NOAA Great Lakes Environmental Research Laboratory

Implementation Plan

GLERL Strategic Plan 2016-2020

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Office of Oceanic and Atmospheric Research

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Introduction

This implementation plan is an extension of the *NOAA Great Lakes Environmental Research Laboratory (GLERL) Strategic Plan 2016-2020: A commitment to integrated scientific research on the Great Lakes and coastal ecosystems*. Developed primarily as an internal document to facilitate the execution of the strategic plan, the implementation plan serves as a compass to further direct the conduct of integrated scientific research at GLERL. In addition, the implementation plan provides explicit guidance on operational support. In alignment with the *NOAA Next Generation Strategic Plan*, GLERL's strategic and implementation plans strive for organizational excellence.

GLERL's organizational structure is comprised of four branches that drive its research agenda including: Observing Systems and Advanced Technology (OSAT); Ecosystem Dynamics (EcoDyn); Integrated Physical and Ecological Modeling and Forecasting (IPEMF); and Information Services (IS). An overview of these branches is presented in the strategic plan, including branch goals, questions, and drivers as well as guiding principles on how each branch functions.

GLERL's implementation plan presents actionable guidance in the following areas: branch paths and milestones; technology transfer; infrastructure priorities; vessel operations; data management; quality, safety, and environmental compliance (QSEC); succession planning; and life cycle management of critical equipment. The overall purpose of the implementation plan is to:

- Operationalize the execution of GLERL's mission, vision, and organizational and branch goals.
- Establish and apply milestones to ensure accountability through a performance measurement process.
- Indentify priorities for the sustainability of GLERL research and operations.

An important linchpin connecting GLERL's strategic plan to its implementation plan is GLERL's approach to scientific research and operations, built upon an adaptive integrated research framework. The framework—as presented on page 19 of GLERL's 2016-2020 strategic plan—is an iterative cycle of research and ecosystem management that is driven by priorities, goals, and research questions. Through the establishemt of paths and milestones, the implementation plan provides action-oriented guidance in the conduct of research and operations. Importantly, the milestones—aligned with the strategic research goals—provide the basis for performance evaluation and assessment of research results/outcomes generated in the implementation phase. In keeping with the adaptive management approach, the evaluation/assessment phase advances ongoing improvements in research through consideration of verified progress, demonstrated value, and the lessons learned from successes and challenges.

GLERL Branch Paths and Milestones (2016-2020)

OSAT Paths and Related Milestones

Goals

1. Expanded use and application of technology to enhance remote sensing capacity to assess ecosystem impacts and for use in modeling and operations.
2. Improved in situ observational capacity to increase number of sites and number of instruments and sensors at those sites.
3. Observational infrastructure (e.g., instrumentation and equipment, mobile and fixed platforms, and data management) provides reliability and flexibility needed for innovation on a long-term basis.
4. Operational capacity that supports research and the transition of products to operations.

Path	Milestones
A. Establish a routine hyperspectral monitoring capability on western Lake Erie and Saginaw Bay, including the use of persistent UAS.	• 2016: Deploy hyperspectral imaging system from aircraft and begin UAS hyperspectral testing. • 2017: Test hyperspectral algorithms capable of detecting and classifying cyanobacterial and algal species and integrate hyperspectral map product into the GLERL HAB Tracker. • 2018: Develop and test UAS docking station on Lake Erie offshore structure. • 2019: Transition hyperspectral imaging capability into operational use for HAB Tracker.
B. Continue development, transfer, testing and optimization of SAR ice type algorithm and CPA (color producing agent) algorithm with NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) to support operational product development.	• 2016: Enhance optical properties database to improve hydro-optical models in collaboration with Michigan Tech Research Institute-MTRI. • 2016: Improve and validate CPA algorithm in optically complex waters in collaboration with MTRI. • 2016: Complete Great Lakes CoastWatch move to new server for improved image and data distribution and accessibility. • 2016: Test Visible Infrared Imaging Radiometer Suite (VIIRS) ocean color data for use in Great Lakes CPA algorithm and HAB algorithm. • 2017: Test and optimize SAR ice type algorithm and CPA algorithm with NESDIS toward operational implementation.
C. Develop real-time HAB, nutrients, and episodic hypoxia monitoring network on Lake Erie and Saginaw Bay.	• 2016: Deploy HAB, nutrients, and hypoxia monitoring buoys on western Lake Erie. • 2016: Deploy HAB and episodic hypoxia buoy on Saginaw Bay • 2017: Extend Saginaw Bay observations to include nutrient monitoring

D. Develop a hypoxia warning capability on Lake Erie.	• 2016: Deploy hypoxia and coastal current monitoring buoys in central Lake Erie. • 2016: Transition the central basin hypoxia-warning buoy into operations by GLOS. • 2017: Deploy a hypoxia-monitoring buoy in the Sandusky Basin. • 2018: Support development of a coupled FVCOM hydrodynamic and hypoxia model to forecast onset and position of the hypoxic water mass in central Lake Erie.
E. Continue to develop and deploy year-round, under-ice systems for ecological and physical observations.	• 2016: Deploy and test bottom-mounted profiler on Lake Erie. • 2016: Deploy ecological observing node on Lake Michigan with active and passive acoustics. • 2016: Deploy sensors for evaporation estimation on ReCON buoys and offshore structures. • 2017: Deploy a year-round, under-ice ReCON station in western Lake Erie reporting waves, currents, temperature, ice characteristics, and HAB data profiles. • 2018: Deploy year-round, under-ice ReCON stations in lakes Superior, Michigan and Huron reporting waves, currents, temperature, and ice characteristics. • 2019: Deploy UAV docking station in Lake Superior. • 2019: Add passive and active acoustics systems to Lake Huron and Lake Superior ReCON stations.
F. Test and evaluate real-time ship-based ice reconnaissance, ice transmittance, mapping algorithm, and ice thickness measurement capability.	• 2017: Measure Photosynthetic Active Radiation (PAR) transmittance of additional major ice types and evaluate for use with SAR ice classification maps to produce PAR attenuation maps of the Great Lakes. • 2018: Evaluate airborne and satellite ice thickness measurement technologies e.g., IceSAT, SAR constellations, and Ground Penetrating Radar.
G. Develop real-time vessel observations capability.	• 2017: Install communications and flow-through systems on LMFS vessels.

EcoDyn Paths and Related Milestones

Goals

1. A holistic understanding of the role of established and potentially future invasive species on Great Lakes ecosystems.
2. An integrated understanding of the spatial organization of the food webs and nutrient use and transport from nearshore to offshore food webs.
3. The capacity to forecast effects of climate change on Great Lakes food webs.
4. A quantitative understanding of the drivers of HABs to predict their concentration, extent, movement, and toxicity.

Path	Milestones
A. Continue LTR program on critical food web variables in nearshore and offshore Lake Michigan to meet management and forecasting needs.	• 2017: Compile long-term data sets from the Muskegon transect studies conducted during 1983-2015. • 2017: Analyze relationships between primary productivity, zooplankton, dreissenid mussels, and climate to determine impacts of multiple stressors on Lake Michigan zooplankton. • 2020: Evaluate whether changes in the lower food web have affected growth, density, and potential recruitment of larval alewife, bloater, and lake whitefish.
B. Continue to define and understand spatial interactions of nutrients and food-web components from microbes to fishes in lakes Michigan and Huron, and their consequences to food web production using state of the art technologies e.g., fisheries acoustics, laser optical plankton counter, and environmental sensors.	• 2016: Improve methodologies used on spatial cruises—integrate MOCNESS into sampling protocol. • 2018: Working with partners, characterize the importance of the microbial food web to planktonic and larval fish production in Lake Michigan. • 2017: Participate in Lake Huron Coordinated Science Monitoring Initiative (CSMI) • 2017 using the lessons learned from Lake Michigan CSMI 2015. • 2020: Understand spatial interactions among nutrients and food web components in lakes Michigan and Huron. • 2021: Develop a suite of ecosystem indicators from spatial data that can quantify the state of the system and the likelihood that it would transition to an alternate state.
C. Continue to monitor the status of benthic macroinvertebrate and dreissenid mussel populations in Lake Michigan and conduct experiments to evaluate factors that affect mussel abundance, feeding, growth, and condition in the Great Lakes as well as mussel impacts on Great Lakes food webs.	• 2016 and 2021: Update dreissenid density and biomass maps for the southern basin and the whole lake (2016, 2021). • 2018: Conduct in situ growth experiments to elucidate observed mussel biomass patterns. • 2019: Complete mussel feeding and growth experiments (at LMFS and Ann Arbor laboratories) to understand field growth observations and calibrate mussel bioenergetics models. • 2021: Define role of dreissenid mussel nutrient capture, excretion, and cycling in the Great Lakes.

D. Develop understanding of drivers of HAB dynamics in Lake Erie for development of tools to predict spatial distribution, extent, seasonal dynamics and toxicity.	• 2017: Include realistic estimates of Microcystis growth rates, mortality rates, and buoyancy in the HAB Tracker Model. • 2017: Detect microcystins using the ESP in western Lake Erie. • 2018: Understand the role of nitrogen in driving toxin production within and between different populations of HABs in western Lake Erie. • 2019: Develop a Great Lakes HAB genetic database to be used for the interpretation of laboratory and field based molecular and genetic ('omics') experiments. • 2020: Understand the interactions of plankton and benthic grazing, light and nutrients on HAB formation and toxicity.
E. Develop ecosystem models to provide scenario-based, nowcast, and forecast applications addressing Great Lakes ecosystem research and management questions.	• 2017: Develop a water quality and lower food web model for 5-day and seasonal forecasts of Lake Erie HAB extent, distribution, and toxicity. • 2017: Develop a Lake Michigan water quality and lower food web model that can be applied for development of nearshore and lake-wide nutrient criteria, and forecasts of prey fish recruitment potential and game fish distribution and migration. • 2017: Develop and calibrate the Atlantis Ecosystem model to evaluate invasive species, climate, and nutrient impacts on food webs and fisheries in lakes Michigan, Erie and Huron. • 2021: Make scenario-based and nowcast/forecast applications for water quality and lower food web models of Lake Erie central basin hypoxia. • 2017: Analyze GLANSIS (Great Lakes Aquatic Nonindigenous Species Information System) data on spatial distribution of established nonindigenous species to improve prediction of species spread and guide monitoring. • 2019: Update GLANSIS Watchlist to include additional species at risk of invading and becoming established in the Great Lakes based on the peer-reviewed scientific literature.

IPEMF Paths and Related Milestones

Goals

1. Integrated modeling system to improve forecast capability of lake hydrodynamics, lake ice, hydrological response, ecological processes, water quality, and climatic variability and trends across spatial and temporal scales.
2. Enhanced/ improved capability for medium- and long-range forecasts by quantifying uncertainty and developing skill assessment tools (long-term, decadal scale climate)
3. Be a trusted scientific leader on prediction of high impact or extreme events, including prediction on water issues of regional and national significance.

Path	Milestones
A. Model integration and model improvement.	• Develop and implement a coupled atmosphere-lake-ice-wave forecasting system. • Develop and verify an ecological forecasting system (EFS) for HABs, hypoxia, and habitat. • Develop an atmospheric-hydrologic prediction system (i.e., Weather Research and Forecast Model for Hydrology (WRF-Hydro)) for the Great Lakes to improve prediction of large-scale water quantity and quality parameters. • Develop a coupled physical/biological model as a first step toward a fully integrated ecological modeling system. • Expand regional modeling efforts to predict the impacts of climate on physical and ecological conditions on a multi-decadal scale. • Provide reliable extended forecasts via ensemble techniques and reduced uncertainty. • Improve model accuracy and extend forecast period by assimilating satellite data and field measurements • Improve FVCOM-Ice model and apply the improved version to all five Great Lakes and the Arctic Ocean
B. Research to Operations (R2O): Research-based models are transitioned to operations through collaboration with NOAA partners.	• See R2O technical readiness chart on page 17.
C. Research to Applications (R2A): Research-based models are transitioned to applications through collaboration with important stakeholders or other government agencies.	• See R2A technical readiness chart on page 18.

D. Continue and expand role in leading internal and external collaboration and, scientific expertise and knowledge transfer on a regional and national level.	Internal • Collaborate with EcoDyn branch scientists and CILER to monitor HABs and hypoxia for use in the development of ecological and water quality models • Collaborate with OSAT branch engineers to assimilate data (field observations or satellite remote sensed data) to improve computer model accuracy. External • Conduct workshops, symposiums, IJC Annex Committees, public presentations, publications in response to policy needs and regional governance • Biannual Inter-agency Water Levels update media tele-conference (spring/ fall for the next 5 years). • 2016-2018: Execution of IAHR Ice Symposium and publication of conference proceedings • Enhance collaboration with Sea-Ice Modeling Working Group • Play a leadership role in Pacific Arctic Group Planning • Great Lakes Water Quality Agreement (Annexes 2 , 4, 9, 10: Nearshore Framework, Nutrient, Climate, Science) • 2016-2020: Continue to provide leadership and expertise on Coordinating Committee on Great Lakes Basin Hydraulic and Hydrologic Data and in this role advance over-lake precipitation products with a goal of publicly disseminating the product • Continue to conduct research and provide scientific leadership in support of GLRI • 2016-2020: Maintain leadership roles on the NOAA Ecosystem Forecasting Roadmap Technical Teams – HABs/Hypoxia, Infrastructure and Planning, Habitat and Species Distribution • 2016-2017: Ecological Forecasting Roadmap deliverables support transition of the HAB Bulletin • 2016 -2020: Support National Water Center team in the development of deliverables for calibrating and evaluating the WRF-Hydro model for the Great Lakes • 2016: Host NOAA-Environment Canada Bi-Lateral Agreement Marine Forecasting Workshop • 2016: Host Bi-National Geo Fabric Workshop • 2016: Continue to provide leadership and expertise for the IJC Adaptive Management Committee to complete work plan for developing lake regulation performance • 2017: Complete model comparison with Environment Canada for Great Lakes hydrodynamic forecast systems
E. Establishing methodology for uncertainty estimation and probabilistic forecasting.	• 2017: Advance seasonal ice forecast incorporating uncertainty estimation • 2018: Develop a nutrient loading model and the skill assessment tools in a Bayesian network framework • 2018-2020: Develop appropriate matrix and tools to evaluate model skills • 2019: Develop skill assessment and uncertainty estimation for HABs forecasting • 2017: Develop seasonal forecast regression models for lake ice cover in all five individual lakes

IS Paths and Related Milestones

Goals

1. A collaborative organizational environment that fosters information flow, transparency, trust, and a team-building approach, and enhances the functionality of GLERL programs and staff.
2. Increased awareness and understanding of GLERL expertise, programs, products, and services among other NOAA programs, NOAA leadership and Congress.
3. Information needs of constituent groups (e.g., other governmental agencies, resource managers, decisionmakers, researchers, media, private industry, educational institutions, NGO's, general public) in the Great Lakes region are met.
4. Recognition of NOAA GLERL as a resource for research products and services utilized by constituent groups and partners in the Great Lakes and beyond.

Path	Milestones
A. Facilitate an internal information flow that promotes a collaborative, interdisciplinary organizational environment.	• Continue to facilitate/support GLERL strategic planning, science leadership, operational leadership. • Maintain and enhance the integration of GLERL programs through a variety of internal communication mechanisms. • Maintain and administer IS operations to ensure continued functionality of GLERL communications.
B. Provide information support to GLERL staff to enhance their functionality.	• Expedite the editing, review, submission, and tracking of scientific manuscripts, posters and technical memorandum. • Continue to support the GLERL science branches by overseeing all aspects of GLERL library services, to include: executing journal subscription process, fulfilling library service requests, and recruiting supplementary volunteer assistance. • Training e.g., media training, program design, etc. (1 per year). • Workshop support (materials, give tours, provide information booklets, promotional materials, social media. • Support VIP site visits. • Provide talking points, slide support, graphics, photography, videos.
C. Raise awareness and promote understanding of GLERL expertise, programs, products and services among other NOAA programs, NOAA leadership, and Congress.	• Execute coordination of GLERL's 5 year science review and strategic plan/ implementation plan (2016). • Serve on and inform OAR's Evaluations Community of Practice (2016-2017). • Provide information support for NOAA and Congressional data calls/information requests. • Promote GLERL expertise and produce a variety of program and reporting documents to document/track impacts.

D. Advance Great Lakes regional collaboration	• IS Chief works in conjunction with Great Lakes Sea Grant Network specialist to establish an MOU to formalize Great Lakes Regional Outreach Extension position (2016). • Coordinate with GLRCT working group to advance their action plan.
E. Identify and meet information needs of constituent groups, while promoting GLER's expertise, products and services.	• Produce a variety of science translation products to promote GLERL scientific research e.g., factsheets; infographics; social media campaign; web site; webinars, seminars, and media teleconferences covering recent research developments; photo, video, and data visualization products; tours; and other miscellaneous outreach and events. • Respond to information requests. • Respond to media requests. • In accordance with NOAA guidance, goals and vision, develop an internal branding and communications guidelines document, that ensures appropriate credit, logo use, taglines etc. and disseminate to the IS team and GLRCT communications and outreach working group (2017).

Technology Transfer

GLERL develops a wide range of products that aid decision-making to sustain resilient ecosystems, communities, and economies. Transferable products can include observational data sets, visualization tools, analysis and forecast products, decision support and situational awareness tools, physical process model parameterizations, assessments, model outputs, climate, ice-hydrodynamic, water budget analyses and reanalyses, publications and other science communication products. These tools are developed in partnership with operational entities across NOAA, foreign and domestic governmental agencies, academic institutions, private industry, and region-specific stakeholders. GLERL's products and services are organized by theme group in the figures below.

Technology Transition Readiness Levels (TRL) are defined as the following:

9 – Actual system "mission proven" through successful operations.

8 – Actual system completed and "mission qualified" through test and demo in operational environment.

7 – System prototyping demonstration in an operational environment.

6 – System/subsystem model or prototyping demonstration in a relevant end-to-end environment.

5 – System/subsystem validation in relevant environment.

4 – Component/subsystem validation in laboratory environment.

3 – Analytical and experimental critical function and/or characteristic proof-of-concept.

2 – Technology concept and/or application has been formulated.

1 – Basic principles have been observed and reported.

Definitions of R2X

R2X

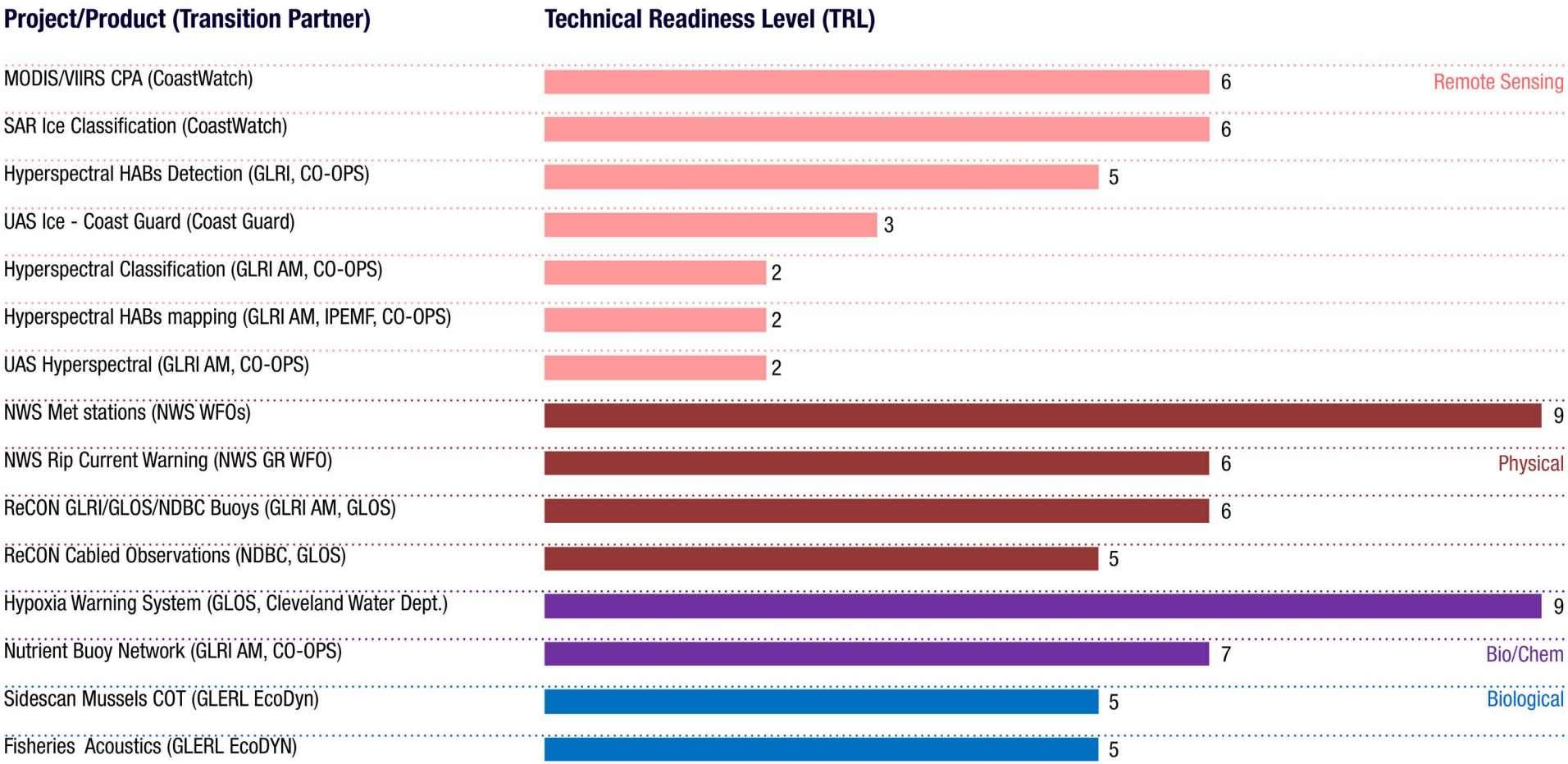
The transition of Research and Development (R&D) to any operation, application, commercialization or other use to include products like 24 hours/7days weather forecasts (typically referred to as research to operations), information products used in resource management (research to application), commercially available in situ sensors (research to commercialization), or government policies, regulations, synthesis of research, public education and outreach (research to other uses) (NAO 216-105A | Policy on Transition of Research to Application).

Research to Operations (R2O)

Operations are defined as sustained, systematic, reliable, and robust mission activities with an institutional commitment to deliver specified products and services (NAO 216-105A | Policy on Transition of Research to Application). R2O is the pathway by which fundamental research is developed into a useful tool or product that is run regularly and automatically. These tools and products provide routine real time and forecast guidance for application and use by the public.

Research to Application (R2A)

Applications are defined as the use of NOAA R&D output as a system, process, product, service or tool. Applications in NOAA include information products, assessments, and tools used in decision making and resource management (NAO 216-105A | Policy on Transition of Research to Application). R2A is the pathway by which information from fundamental research is transferred to decision-makers or other end users in a non-operational framework.



Technical Readiness Level (TRL) Definitions

1: Basic principles have been observed and reported.

2: Technology concept and/ or application has been formulated.

3: Analytical and experimental critical function and/or characteristic proof-of-concept.

4: Component/subsystem validation in laboratory environment.

5: System/subsystem validation in relevant environment.

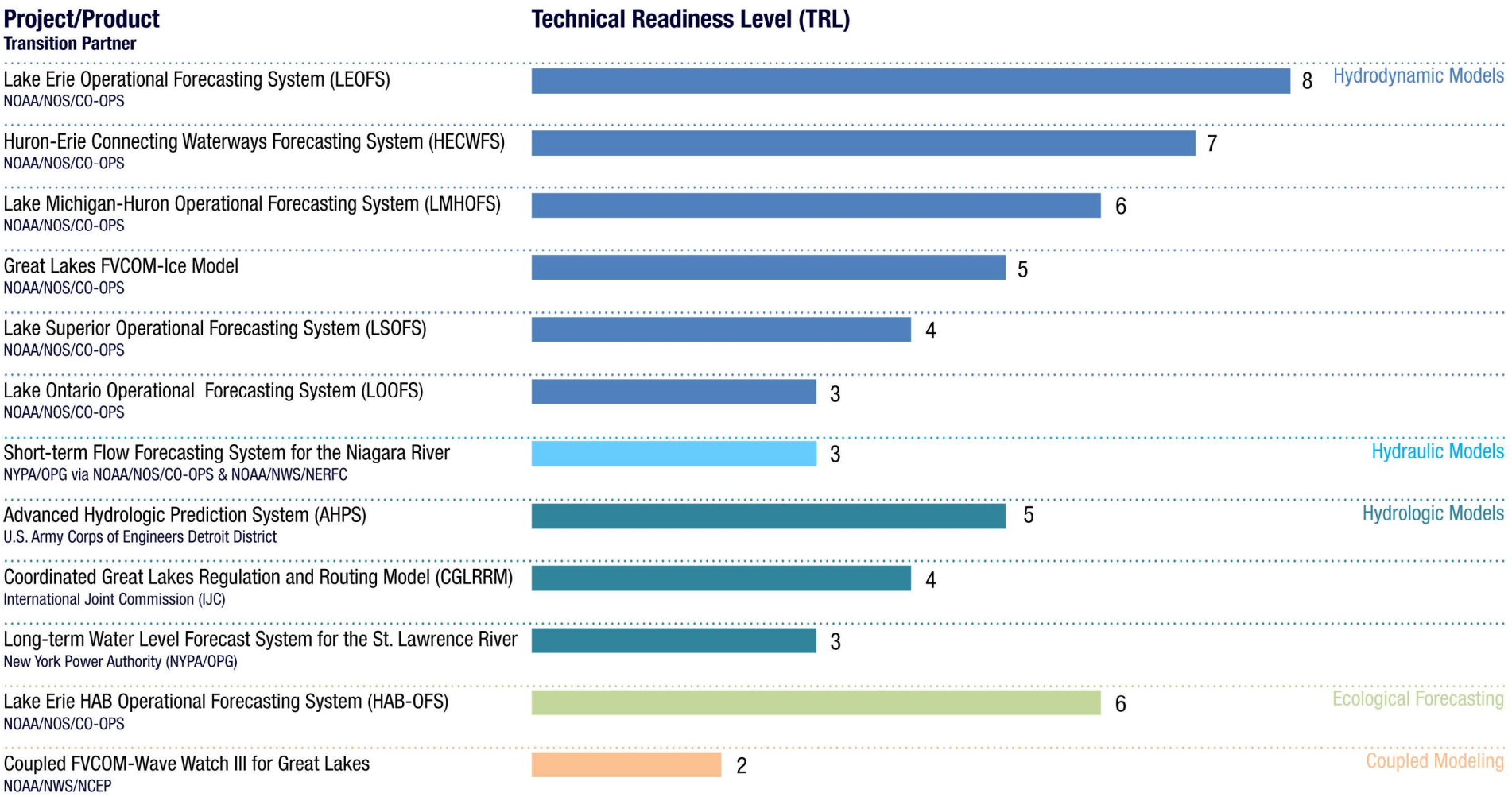
6: System/ subsystem model or prototyping demonstration in a relevant end-to-end environment.

7: System prototyping demonstration in an operational environment.

8: Actual system completed and "mission qualified" through test and demo in operational environment.

9: Actual system "mission proven" through successful operations.

Technical readiness level of OSAT products.



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Technical readiness level of IPEMF research to operation (R2O) products.

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Technical readiness level of IPEMF research to applicatoin (R2A) products.

Infrastructure and Priorities

Administration

The administrative staff in Ann Arbor, and Muskegon, Michigan provides operational support to GLERL staff and internal partners in the areas of personnel, budgeting, training, time and attendance, travel, office support, property, facilities, security, procurement and contracts. GLERL's administrative staff serves as a team of professionals committed to the delivery of innovative, effective and efficient customer services while maintaining fiscal integrity.

Priorities of the administrative team:

- Provide effective services by ensuring that administrative staff is appropriately trained in budget, procurement, time and attendance, and travel procedures.
- Enhance staff expertise and maintain certifications.
- Provide GLERL management with staffing summaries for evaluation of the laboratory's staffing plan.
- Collate and track funding decisions for scientific projects and operational accounts.
- Improve efficiencies in administrative processes and operations.
- Provide a safe, healthy, and secure work environment through facility oversight and building improvements.

Information Technology

The Information Technology (IT) team provides researchers and support staff with advanced data processing and storage capacity as well as basic computer and telecommunications capabilities. IT services include integrating computer systems, coordinating and providing training, negotiating and managing information technology related contracts, and technology assistance and support.

Priorities of the information technology team:

- Educate staff on the need for security to be everyone's business.
- Provide reliable and secure IT infrastructure hardware and software.
- Promote continuous learning and provide formal training for IT staff career development.
- Leverage emerging technology and software for innovative new solutions in addressing common IT challenges.
- Maintain a technological environment that enables GLERL staff to expeditiously access vital information using the most efficient and cost effective system hardware and software.

Lake Michigan Field Station

Located on Lake Michigan's Muskegon Lake Channel, GLERL's field station occupies three buildings and houses research staff, vessel crew, a marine superintendent, and administrative personnel.

The LMFS is strategically positioned on Lake Michigan to provide support to the local and regional community by further developing NOAA's role in freshwater ecology, ecosystems management, coastal management, and water-based commerce. This field station promotes long-term observations, field work, and process studies essential for understanding and developing future ecological services. Additionally, the proximity of the field station to Lake Michigan provides a unique opportunity for engagement with tourists, recreational users, and members of the community.

Priorities of the LMFS team:

- Ensure safety and security of the LMFS work environment.
- Enhance LMFS laboratory and workspace facilities to support experimental and process-based research, including the new construction of LMFS building 3.
- Take advantage of the LMFS's proximity to Lake Michigan LTR sites, providing the capacity to process time-critical samples immediately after collection in the LMFS EcoDyn lab and the ability to sample during episodic events e.g., upwelling, spring flooding, or during short weather windows during inclement periods.
- Increase capacity for "wet testing" of instrumentation and scientific mooring preparation and deployment, thus enhancing Marine Instrumentation Laboratory (MIL) capabilities.
- Focus on place-based opportunities for community engagement, outreach and education.
- Enhance public relations with partners from local and the regional west Michigan area government and organizations.

Vessel Operations

Vessel operations, based at the LMFS, support GLERL science branches by providing a safe and secure work environment in the conduct of scientific research. Additionally, vessel operations provide expertise to NOAA in small research vessel (SRV) operations. The mobility of GLERL vessels offers unique place-based opportunities for communications and education at Great Lakes Ports of Call.

Priorities of vessel operations:

- Acquire, manage, and maintain GLERL's vessel fleet to meet current and new initiatives and long-term critical capabilities e.g., vessel fleet recapitalization.
- Provide licensed captains and well-trained crews that implement best practices in promoting safe and efficient field research.
- Manage efficient coordination of ship scheduling for GLERL and regional partners, including use of sampling gear and applied technologies.
- Maintain leadership for Great Lakes regional research vessel coordination such as the Great Lakes Association of Science Ships.
- Provide technical assistance, engineering, maintenance, overhauls, and modifications to support vessel best management practices.
- Maintain recognition as experts and leaders in marine innovation, through the following:
  - Continued leadership in design, enhancement of technical expertise, and certification for the advancement of Green Initiatives, including 'Green Ships.'
  - Building on extensive experience in repurposing and redesigning vessels and providing expert consulting services on an agency-wide scale.
  - Ongoing exploration of innovative approaches for the development and use of marine technology.
- Engage stakeholder groups through the use of vessels as a place-based platform for community outreach.
- For further information on the strategic vision for vessel operations, see Appendix D (currently in progress).

The Ann Arbor Facility

GLERL leases a customized 45,000 square foot facility in Ann Arbor, Michigan which houses:

- 101 offices
- 5 conference spaces (including a 150-seat lecture hall)
- 17 laboratories (11 wet labs, 6 dry labs)
- 2 computer labs
- 14 storage areas
- 10,000 square foot outdoor wareyard

Shared office space serves as a base for staff from NOAA's Great Lakes Cooperative Institute as well as partner agencies including NOAA National Ocean Service (NOS) Marine Sanctuary Program, NOAA National Marine Fisheries Service (NMFS) Habitat Restoration Program, NOAA Great Lakes Regional Collaboration Team, Great Lakes Sea Grant, and the International Association for Great Lakes Research. The facility also serves as a physical hub for regional collaboration within its conference spaces

The laboratories—managed and coordinated by the GLERL lab team—house instrumentation and equipment for use by GLERL and NOAA Cooperative Institute and visiting scientists. The facilities design allows for both dedicated and flexible lab spaces.

The dedicated laboratory spaces include:

- The Biological Preservation Laboratory and Microscope Room, used to sort, identify and count preserved microbial organisms, phytoplankton, zooplankton, larval fish, and benthos for food web studies.
- The Molecular Biology Laboratory, used to implement molecular techniques for measuring HAB toxins and genetics.
- The Limnology Laboratory, used to analyze water chemistry, including chlorophyll concentration.
- The Experimental Biology Laboratory, used to conduct small scale experiments and includes cinematography capabilities for observation and experiments with plankton and benthos.

Priorities of the lab team:

- Ensure laboratory space is available for use by researchers needing it
- Maintain state-of-the- art laboratory instrumentation and equipment.
- Ensure laboratory staff is properly trained on various instruments.

Marine Instrumentation Lab

Within the Ann Arbor lab facility, the Marine Instrumentation Laboratory (MIL) provides the resources necessary to collect in-situ data from the Great Lakes and other areas of interest. The MIL uses a multidisciplinary approach in data acquisition, instrumentation and mooring design, fabrication, calibration, deployment and retrieval, real-time communications, data analysis, and quality assurance. The field experience of the MIL staff is also vital to assure success in the harsh, challenging marine environment. As such, the MIL functions in the collection of measurements of scientific parameters from the real world into the data used by GLERL and its partners for scientific research.

Priorities of the MIL team:

- Develop and prototype new and cutting-edge in-situ data collection techniques.
- Develop techniques to collect data year-round in the Great Lakes, including under-ice observations.

- Improve the efficiency of in-situ data collection.
- Improve the collection of real-time data for use by GLERL and its partners.

Quality, Safety, and Environmental Compliance

The quality, safety, and environmental compliance (QSEC) officer fosters a work environment where operations are conducted in a safe environmentally compliant manner, while producing quality products and achieving outcomes that meet the needs of GLERL customers. A full plan will be developed to guide GLERL staff on quality, safety, and compliance issues; a summary of this plan is outlined in Appendix E (currently in progress).

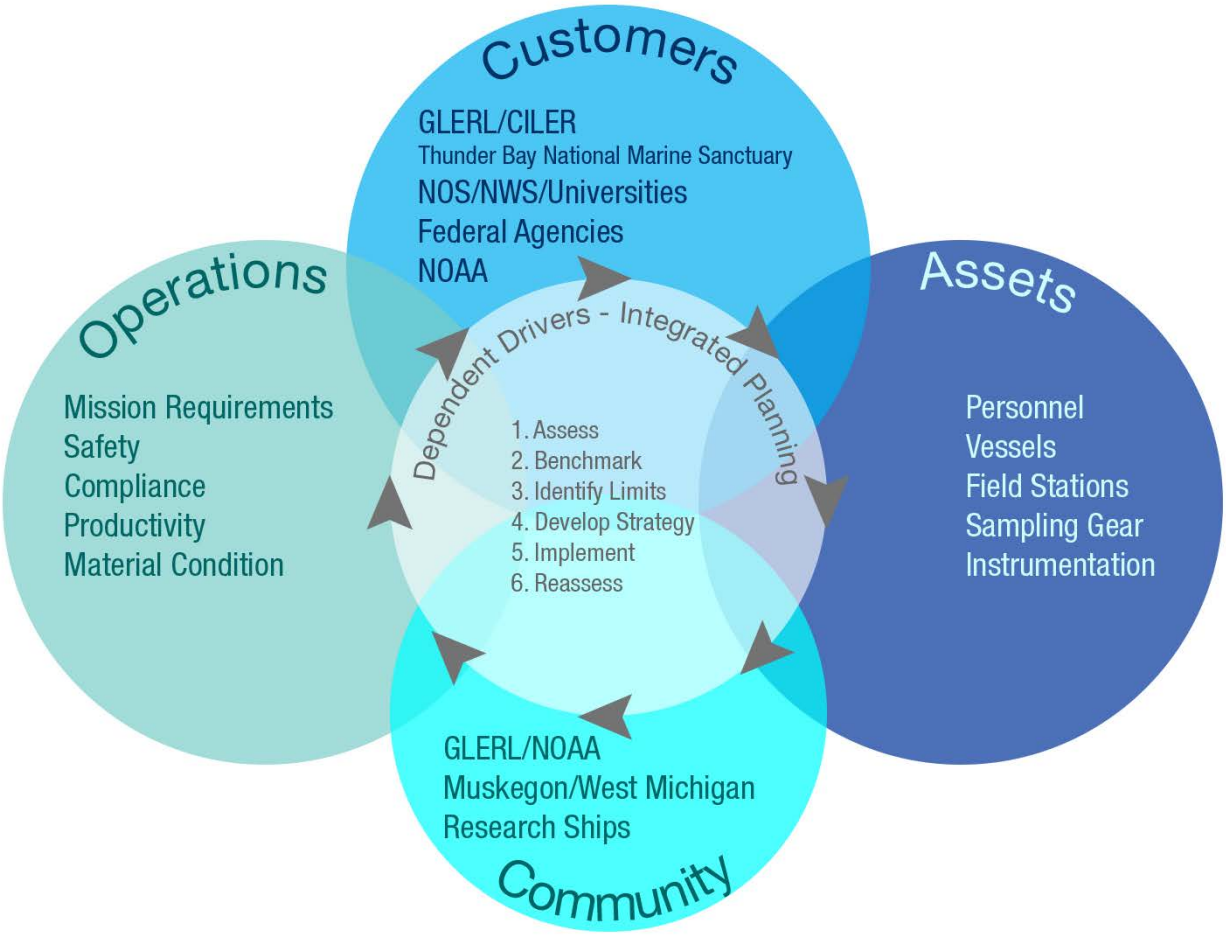
Priorities of the QSEC officer:

- Continue to improve GLERL's safety and environmental compliance programs with participation from the safety committee, chaired by the QSEC officer.
- Ensure adequate safety and environmental compliance staffing at GLERL facilities.
- Improve the project review process to include: the voice of the customer needs; planning documentation, including a NEPA review; an evaluation of progress/performance component that includes "lessons learned" for continuing projects; and evidence-based decision making.
- Strengthen project planning and performance management activities of approved projects.
- Advance data management and quality assurance/quality control activities through routine development and use of data management plans.
- Advance Information Quality Act through routine use of NOAA Guidelines.
- Promote organizational excellence through the advancement of a comprehensive quality management plan.

Lake Michigan Field Station and Vessel Operations

GLERL's Lake Michigan Field Station (LMFS) and Vessel Operations are valuable NOAA assets that play a critical role in supporting integrated scientific research on the Great Lakes ecosystem. Strategically positioned on the eastern shore of Lake Michigan, the LMFS provides both small boat and deep-water docking capabilities for GLERL vessels. The operation of GLERL's vessel fleet, in conjunction with the field station, provides the infrastructure necessary to promote Long Term Research (LTR) observations, field work, and process studies essential for understanding the Great Lakes ecosystem and the ecological services provided by the lakes. The location of the LMFS and vessels on the shores of Lake Michigan also enhances GLERL's connection to the local and regional community, further supporting NOAA's role in freshwater ecology, ecosystems management, coastal management, and water-based commerce.

To effectively support scientific advancements over the next five years, capacity planning of GLERL's LMFS and Vessel Operations is critically important. Planning must be responsive to future science priorities— including consideration of project ideas and proposals— as part of the process to assess infrastructure, operational and equipment needs. Vessel Operations must specifically plan for vessel replacement and retrofitting, size and speed, geographic scope of service, and other capabilities. Through this process, organizational resources can be prioritized and partnership opportunities identified and leveraged to address unmet needs.



Strategic planning for vessel operations takes into account the business elements: customers, asset management, operations, and community through adaptive management principles. This allows for best utilization of resources, maintains core capabilities, and incorporates emerging technologies.

GLERL's LMFS and Vessel Operations are coordinated to provide safe, reliable, and innovative service to support integrated scientific research for NOAA and external partners. In addition, both the field station and vessels provide opportunities for communication, outreach, and education for NOAA and partners, academic institutions, and local and regional communities. Integral to GLERL's Vessel Operations is planning for short-term and future needs, driven primarily by scientific goals and objectives.

Guiding Principles

- Facilitate the conduct of field science (e.g., observations and process studies) that meet the requirements for GLERL researchers, NOAA interests in the Great Lakes, and partner institutions.
- Achieve safety and regulatory compliance in all aspects of operations and asset management for GLERL's field station and vessels.
- Maintain uninterrupted vessel service by addressing unmet needs on a proactive basis.
- Establish resources and systems for best management of vessel material condition and platform effectiveness.
- Advance marine technology initiatives that support NOAA's stewardship and operational goals.
- Invest in personnel development and create career path opportunities.
- Embrace the "One NOAA" concept through support of all NOAA interests in the Great Lakes region and contribute to NOAA's priorities for vessel management.
- Provide value as a national, regional, and community resource.

Lake Michigan Field Station

The LMFS houses laboratory facilities, supporting GLERL research focused on long-term ecological observations, fundamental research on ecosystem processes, and the development of models critical to understanding ecosystem structure and function. Outcomes from this research play an important role in managing water quality, fisheries, and other ecosystem services in the Great Lakes. The base-funded LTR program on Lake Michigan—a flagship monitoring program led by EcoDyn—integrates a core set of long-term observations on biological, chemical, and physical variables, with short-term process studies and field experiments for understanding and forecasting ecosystem change. The field station's proximity to Lake Michigan LTR sites provides the capacity to process time-critical samples immediately after collection in the LMFS EcoDyn laboratory and to sample during natural events (e.g., upwelling, spring flooding) or short weather windows during inclement periods. The LTR program is unique among federal agencies and academic institutions in its long-term commitment to seasonal observations of pelagic and benthic food webs in nearshore, transitional, and offshore waters.

By providing direct access to Lake Michigan, as well as the other Great Lakes, the LMFS not only contributes to the success of observation-based programs, but also supports the conduct of in-depth process studies with potential for increasing complexity. Currently, plans are underway to reconstruct the LMFS Building 3, allowing for the science laboratories to be consolidated within one building, in complete compliance with safety regulations. Plans for the reconstruction of Building 3 will provide increased capacity for laboratory facilities needed to conduct process experiments that must be done with "fresh" organisms sampled directly from the field. This building project also plans to provide additional space for visiting scientists working with the EcoDyn group on critical issues.

Vessel Operations

Important factors driving the operation of vessels at GLERL are science goals and objectives, operational requirements, and customer needs. It is imperative to provide a safe and secure work environment, support effective field operations, and operate in compliance with federal regulations. In addition to providing a platform in the conduct of GLERL integrated scientific research, valuable expertise is provided by GLERL's

Vessel Operations to NOAA in the operation of small research vessels (SRV). The mobility of GLERL's vessel fleet also offers unique place-based opportunities for communications, education, and outreach at Great Lakes ports of call.

To address the challenges encountered in the operation of GLERL's vessels, consideration is given to the following business elements: addressing customer needs, providing effective capital and asset management, developing operations, and serving the community. Simultaneous examination of these elements, described below, provides a holistic and sustainable long-term strategy for vessel operations in meeting GLERL's research needs as well as those of other Great Lakes customers.

- Addressing Customer Requirements and Needs: Identify customers, partners, relationships, and responsibilities in the Great Lakes region.
- Managing Assets: Create a vessel inventory and fleet renewal plan based on customer requirements and best management of assets. As part of this element, maintain development of LMFS facility infrastructure in support of long term group activities e.g., scientific research and outreach.
- Developing Operations: Define resource capabilities and professional development plans accounting for long-term product development, vessel and customer requirements.
- Serving Community: Ensure peer and public engagement in the operations of vessels supporting research and outreach that is integrated with local, national, and regional community initiatives.

This comprehensive approach to the Vessel Operations strategy, inclusive of all of customer needs, helps to balance the cyclical nature of GLERL research. Changes in GLERL's geographic focus and scientific priorities are best supported by maintaining capabilities for a diverse customer base.

The management of GLERL's LMFS and Vessel Operations are guided by the following goals, paths, and milestones.

Goal

1. Established comprehensive, long-range plan for Vessel Operations that allows for capital management to ensure innovative and effective (uninterrupted) vessel service in support of GLERL science.

Path	Milestones
A. Define scope of operations (GLERL, regional or limited).	2016 • Host a workshop with GLERL principal investigators (PIs) to initiate planning on a two, five and ten-year cycle to identify vessel needs in response to science goals and paths/objectives for integration as the foundation for the Vessel Operations plan. • Define scope of Vessel Operations (GLERL, regional, or limited) and draft organizational structure through GLERL's management team. • Complete a needs assessment of vessel support, if required, for the Great Lakes region based upon workshop(s) with all NOAA interests and their partners. • Establish, if required, a draft collaborative structure and funding plan among NOAA partners. • Establish, if required, intra-agency agreements and external MOU's. • Present capital and R&M (Repair & Management) budgets in a five-year format. • Present staff resource requirements in a three-year format. • Create a funding model to support multi-year capital plan. 2017 • Conduct a phased implementation of new scope of operations. • Establish vessel schedule based on a three-year window.
B. Identify customers, partners, relationships, and responsibilities in the Great Lakes region.	
C. Create an organizational structure reflective of the requirements of items A and B.	
D. Establish inter-agency agreements and memorandums of understanding that support items A, B and C.	
E. Identify mechanisms to fund the Vessel Operations plan that do not compete with science needs.	
F. Extend vessel scheduling to a three-year window.	

Goal

2. Creation of vessel inventory and fleet renewal plan based on science goals and objectives, customer requirements, and best management of assets.

Path	Milestones
A. Identify resource priorities and potential partnerships to maintain a high-performing vessel fleet as the basis for establishing a vessel recapitalization plan.	2016 • Validate GLERL interest in a small research vessel (SRV) platform and renew RV Laurentian lease with end of service life defined. • Complete rebuild of R4108, conduct sea trials and commission for service. • Fully integrate the defined scope of operation (path/objective) with the fleet inventory requirements and define new/additional assets (renewal plan). • Complete the Laurentian's 5-year dry-dock inspection (life cycle is established). • Complete long-term SRV platform needs assessment and identify supporting partners, funding mechanisms and operational structure. • Establish NOAA Great Lakes regional fleet panel with the representation needed to assess future vessel needs in the Great Lakes.
B. Establish metrics for current fleet material condition and mission suitability.	
C. Integrate fleet inventory with Vessel Operations plan to generate a 10-year requirements/assets matrix.	2017 • Implement year one of capital renewal plan. • Assess regional fleet needs and develop funding strategy. 2018 • Request NOAA Headquarters to include SRV in the FY2019 Presidential Budget.
D. Acquire appropriate number and class of vessels to support customer requirements.	2019 • New SRV design contract is awarded. 2020 • New SRV building contract is awarded.
E. Maintain vessels to meet mission requirements and anticipate emerging technologies.	

Goal

3. Defined resource capabilities and professional development plans reflective of long-term product, vessel, and customer requirements.

Path	Milestones
A. Define core capabilities and infrastructure to best support operation, mission, compliance, and technology requirements.	2016 • Complete core capabilities and associated infrastructure requirements report based upon current scope; draft requirements to reflect any changes in future scope. • Create a scalable framework to define support requirements (personnel and equipment) that allows for phased implementation and personnel development.
B. Establish a long-term staffing plan for vessel management, operations, and shore support positions.	• Scope out vessel-based science technician position. 2017 • Establish a five-year capability, infrastructure and equipment plan. • Establish a three-year staffing plan.
C. Establish support infrastructure and equipment plan.	• Establish a three-year personnel development plan. 2018 • Establish relationship with Office of Marine and Aviation Operations (OMAO) through NOAA Corps Officer Billet.
D. Develop opportunities for career path development and professional growth.	• Formalize regional priority and allocation process with agency partners, if required.
E. Explore opportunities to overcome limitations of seasonal field work.	

Goal

4. Development of LMFS facility infrastructure that will support long-term group activities in areas of scientific research, as well as communication and outreach.

Path	Milestones
A. Create plans for best utilization of current resources and achieve positive public image.	2016 • Assess current status of infrastructure and identify gaps, deficiencies, and corrective actions. • Integrate LMFS science facility requirements with LMFS vessel facility requirements. • Conduct an assessment of science needs for incorporation in the design of Building 3. • Determine the feasibility of the Building 3 project based on available funds and footprint. 2017 • Complete Laurentian dock improvements. • Complete improvements to conference meeting infrastructure. • Award of Building 3 contract. • Construction of Building 3. 2018 • Operation of Building 3.
B. Explore agency, partner, and commercial infrastructure alternatives to meet projected requirements.	
C. Plan for capacity building and sustainment of the LMFS, as feasible.	
D. Integrate co-location of partners where there is mutual benefit.	
E. Develop satellite dockage and shore resources.	

Quality, Safety and Environmental Compliance

GLERL embraces the operational and organizational excellence goals of the U.S. Department of Commerce (DOC) and NOAA, striving for continual improvement. In the conduct of research and operations, GLERL uses a traditional quality management approach (QMA) coupled with the *Baldrige Performance Excellence Program*, offering "an integrated approach to organizational performance management that result in: 1) delivery of ever-improving value to customers and stakeholders, contributing to ongoing organizational success; 2) improvement of overall organizational effectiveness and capabilities; and 3) organizational and personal learning."[1] GLERL's QMA organizational components include research and operational activities, customer service, workforce engagement, information technology practices, data management, safety and environmental compliance, administrative services, and business practices. In conducting its QMA in conjunction with the *Baldrige Performance Excellence Program*, GLERL applies a holistic approach which considers all of its working components to advance the mission, vision, and goals established as part of NOAA GLERL's Strategic Plan 2016-2020: *A commitment to integrated scientific research on the Great Lakes and coastal ecosystems.*

At GLERL, quality management is administered in conjunction with safety and environmental compliance. GLERL's QMA program on quality, safety, and environmental compliance (QSEC) operates to ensure that laboratory and vessel activities, workforce, and work environment comply with federal policies, regulations, and standards. In the following section, the components of quality, safety, and environmental compliance will be covered, including the goals, paths, and milestones set forth as guidance for the QSEC program.

To ensure a safe and healthy working environment, GLERL develops programs to comply with the NOAA Safety Policy (NOAA Administrative Order (NAO) 209-1).[2] The NAO complies with Executive Order 19296 (Occupational, Safety and Health Program for Federal Employees), 5 U.S.C. 7902, "Safety Programs," and Sections 19 and 24 of the Occupational Safety and Health Act (OSHA) of 1970. Also delineated under the NAO are the rules, responsibilities, and processes necessary to promote a safe work environment for all NOAA employees as well as GLERL's co-located partners and affiliated contractors.

As a federal laboratory under NOAA, environmental compliance at GLERL is driven by NOAA's Environmental Compliance Program as laid out in NAO 216-17 (effective 09/29/1998). This directive "requires… operating units to adhere fully to environmental pollution control laws, regulations, and directives and to cooperate with Federal, state, and local agencies in improving the quality of the environment."[3] The directive, NAO 216-17, "specifically directs the head of each operating unit (such as the NOAA Administrator) to develop and implement programs and activities to prevent or minimize adverse impacts on environmental quality." Environmental regulations that apply to GLERL activities include the National Environmental Policy Act (NEPA), the Resource Conservation and Recovery Act (RCRA) and other federal and state regulations.

The lead for GLERL's QSEC program is responsible for coordinating activities in the areas of quality management, safety, and environmental compliance. The QSEC program lead reports to the Deputy Director, and obtains leadership support for program execution. Quality, safety and environmental compliance activities are also promoted by participation of the QSEC lead on GLERL's Infrastructure Council as well as NOAA and OAR level committees and working groups. To further advance compliance and best practices, a safety and environmental compliance committee has been convened at GLERL to address ongoing and emerging

1 Baldrige Performance Excellence Program. 2015. 2015-2016 Baldrige Excellence Framework: A Systems approach to Improving Your Organization's Performance. Gaithersburg, MD: U.S. Department of Commerce, National Institute of Standards and Technology. http://www.nist.gov/baldrige and https://www.nist.gov/baldrige/how-baldrige-works

2 NOAA Administrative Order (NAO) 209-1 NOAA Safety Policy http://www.corporateservices.noaa.gov/ames/administrative_orders/chapter_209/209-1.html

3 NOAA Office of the Chief Administrative Office: NAO 216-17: NOAA Environmental Compliance Program: http://www.corporateservices.noaa.gov/ames/administrative_orders/chapter_216/216-17.html

issues. The committee members represent the various groups across GLERL to maximize customer engagement opportunities and promote program development and organizational excellence using a continual improvement approach. GLERL's resources on health, safety, and environmental compliance are accessible for internal use by staff on GLERL's intranet website.[4]

Quality

A traditional QMA based on the four phases: **plan**, **do**, **check**, and **act** (**PDCA**)[5] is applied in the conduct of research and operations at GLERL. The PDCA process, described below, is tailored for use at GLERL through integration with research management and operations via GLERL's Annual Operating Plan (see sidebar):

- Plan by defining priorities, establishing goals and research questions, designing science projects and internal processes, and developing an approach for assessment;
- Do (through the conduct of) the projects and related internal processes;
- Check the project/process results to goals through assessment and evaluation;
- Act accordingly to make necessary modification(s) based on challenges/problems, lessons learned, and successes.

Annual Operating Plan (AOP): *The yearly budget execution plan put in place by GLERL using a project planning and budgeting process.*

The AOP process is applied to maximize best use of resources by assessing project needs and previous results compared to goals. Projects are based on GLERL's strategic priorities and continually evaluated based upon challenges/problems, lessons learned, and successes.

As discussed in GLERL's 2016-2020 strategic plan under the "Approaches" section (pages 17-23), GLERL's approach to adaptive integrated research provides an iterative, long-term systematic process to refine research management and ecosystem management. This is accomplished by taking advantage of new knowledge gained from the outcomes of scientific research and related operations activities. The graphic on the following page illustrates how the QMA phases (plan, do, check, act) map onto the *Research Management* (left loop) of *GLERL's Adaptive Integrated Research Framework* (page 19 of GLERL's 2016-2020 strategic plan) that is also aligned with GLERL's AOP process. *Leadership is working with GLERL scientists and staff in using this model to facilitate adaptive integrated research with a long term commitment to advance organizational and operational excellence.*

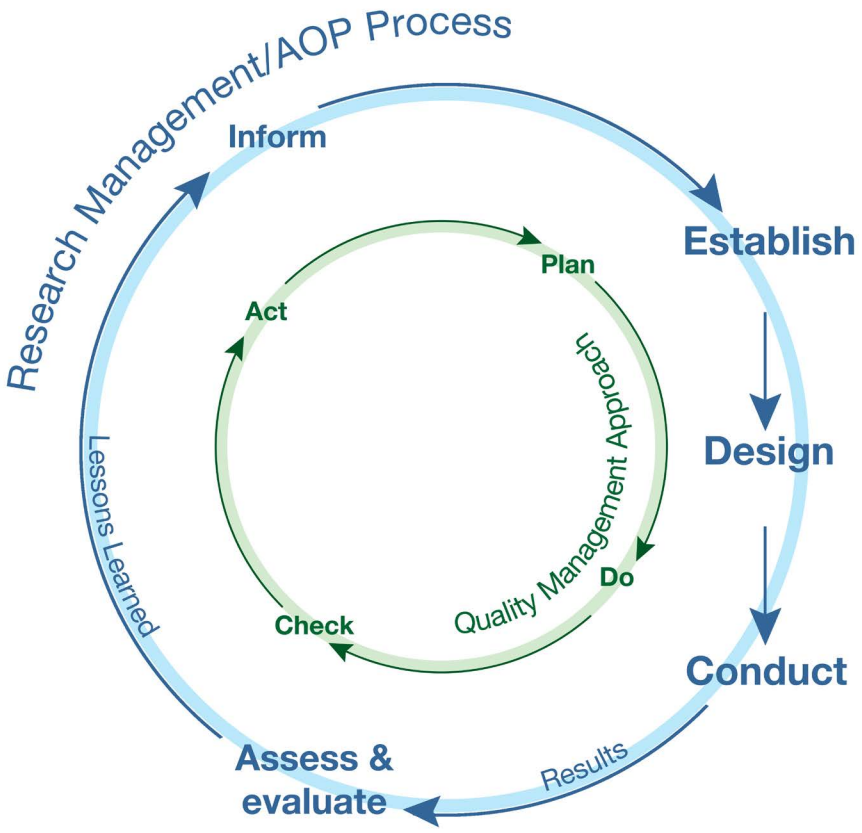
To advance the DOC's *Baldrige Performance Excellence Program*, GLERL's research program/AOP process integrates the program's "Baldrige Criteria" into its quality management PDCA approach. GLERL's adaptation of the Baldrige Criteria is described below.

- **Leadership** at GLERL ensures a supportive environment for decision making, taking intelligent risks, communicating, training and motivating the workforce, developing future leaders, reviewing organizational performance, and recognizing workforce members.
- **Strategic Planning** provides a framework by which to apply a consensus-based approach in defining organizational and branch goals that include measures of progress. GLERL's strategic plan guides the development and implementation of projects within GLERL's AOP process and executes evaluation to guide project/program changes, for improvement, through an adaptive approach.
- **Customer Focus** considers how GLERL engages its customers to achieve organizational success that includes processes for soliciting and considering stakeholder input, building customer relationships through engagement and support, and using customer information to improve and identify opportunities for innovation. During the strategic and AOP planning process, the customer input is considered to ensure alignment of GLERL's activities with priority customer needs throughout

4 GLERL's Intranet website (http://intranet/) is only internally available to GLERL staff and co-located partners.

5 NOAA Science and Technology Quality Management Glossary:
https://www.st.nmfs.noaa.gov/data/Quality-Management/qm-glossary

Mapping the QMA PDCA onto GLERL's Research Management



the entire planning process. Those customers relevant to GLERL's operations include internal (e.g., GLERL and NOAA Cooperative Institute staff members, including contractors) and external (e.g., other NOAA line offices, regulatory entities, stakeholders, the NOAA headquarters, the general public, and so on).he general public, and so on).

- **Measurement, analysis, and knowledge management** addresses the selection, collection, analysis, management, and improvement of GLERL's data, information, and knowledge assets. In addition, consideration is given to the processes of learning, managing information technology, and reviewing findings to improve performance. To support measurement, analysis, and knowledge management, GLERL's Research Management/AOP process includes a framework for data and product management. Evaluation based on performance measures is applied to support continual improvement (application of lessons learned) in the state of organizational knowledge.
- **Workforce Focus** creates a work environment conducive to high performance by considering and integrating capability and capacity needs of GLERL's workforce, as appropriate. This effort includes engagement, management, and development to maximize alignment with organizational and branch goals.
- **Operations Focus** addresses how GLERL designs, manages, conducts, and improves its products, services, and work processes, including safety and environmental compliance. Outcomes from these activities improve operational effectiveness in delivering customer value and achieving organizational stability, success and sustainability.
- **Results** document progress regarding GLERL's performance and improvements, evaluated in all key areas of QMA based on research and operations outcomes.

GLERL's Quality Management PDCA Approach Integrating the Baldrige Criteria

The quality management PDCA approach presented in the graphic on the following page depicts how the Baldrige Criteria are integrated into GLERL's conduct of operations, scientific research, and business practices.

The quality management PDCA approach is described in more detail below, including its integration with GLERL's *Research Management* cycle (bolded text excerpted from the left loop of *GLERL's Adaptive Integrated Research Framework*, page 19 of NOAA GLERL's 2016-2020 strategic plan). This multidimensional approach is being pursued in an effort to most effectively advance GLERL's operational and organizational excellence goals.

Plan: Define (priorities), Establish, Design

*The **planning** phase in the QMA cycle involves **defining priorities, establishing goals and research questions,** and **designing science projects and internal processes supporting research goals.** During the planning process, the following elements are addressed under each of the Baldrige Criteria:*

- Leadership:
  - Set priorities and direction of the laboratory using a risk management approach, to ensure that the benefits are greater than the risk.
  - Ensure fair and equitable distribution/use of resources during the AOP process to accomplish organizational priorities.
  - Communicate priorities/direction of research projects/programs and internal processes of the laboratory.
  - Promote desired science outcomes by adhering to the quality management approach of the AOP process.
  - Align GLERL's AOP with OAR's 3-year budget cycle.
- Strategic Planning:
  - Ensure mission alignment.
  - Engage workforce in the process of development.
  - Address customer needs/expectations.
  - Include existing/external commitments.
  - Reserve 10% of capacity for program change, if needed or desired to address new priorities or opportunities, and to maintain agility and support for innovation.
  - Develop and integrate evaluation, metrics, and milestones early on in the AOP process.
  - Develop plans for internal processes, such as data management, safety and environmental operations, staff succession, and hiring.
- Customer voice and priorities:
  - Assess stakeholder priorities/needs and documents on a project-specific basis early on in the project/program planning phase.
  - Establish a process to maintain engagement, as appropriate, of customers (such as those listed in the sidebar on page 32).
- Measurement, analysis, and knowledge management:
  - Determine project outcomes e.g., publications, services, models.
  - Establish performance measures to track progress in achieving the mission and goals of the laboratory.
  - Establish measures of project success, such as milestones and metrics.
  - Develop data management plan.

Quality Management Approach Integrating Baldrige Criteria

Baldrige Criteria Key:

leadership

strategic planning

customer focus

measurement, analysis & knowledge management

workforce engagement

operations focus

results

- Workforce Focus:
  - Ensure that contributions by all facets of the workforce to organizational mission and project/program goals are recognized/understood.
  - Determine realistic allocation/expectation of support staff services.
  - Ascertain realistic expectation of research time that should be diverted to administrative duties e.g., development of AOPs, data management plans, Quality Assurance Project Plans (QAPPs), Standard Operating Procedures (SOPs); supervision/oversight of project personnel including on-the-job training; procurements; new hires; etc.
  - Develop transparent staffing plan and hiring process that are communicated, and followed.
  - Establish Individual Development Plans (IDP) to advance careers that accounts for the time needed to execute the IDP from the personnel resource pool.
  - Provide opportunities for engagement supporting input and feedback loop/mechanism.
  - Encourage culture of diversity and inclusiveness supporting "One GLERL."

GLERL's Customer Base

Parent Organizations: *U.S .Department of Commerce, NOAA Headquarters, OAR*

Regulatory Agencies: *U.S. Environmental Protection Agency (USEPA), OSHA, Michigan Department of Environmental Quality*

Internal: *GLERL management, GLERL workforce, and building occupants from other organizations (NOAA line offices, NOAA Cooperative Institutes, Thunder Bay Marine Sanctuary, Great Lakes Restoration Initiative, Great Lakes Sea Grant, International Association of Great Lakes Research, contractors, volunteers)*

NOAA Leadership and Line Offices: *Oceanic and Atmospheric Administration (OAR), National Weather Service, National Ocean Sciences (NOS), NOAA Satellite and Information Service (NESDIS), National Water Center*

External Partners: *USEPA, U.S. Geological Survey, U.S. Army Corps of Engineers, Environment Canada, International Joint Commission, Great Lakes Fishery Commission, Great Lakes Commission, academia, tribal authorities*

Users: *The public user groups and stakeholders with a vested interest in GLERL's research and application.*

- Operations Focus:
  - Identify/establish Standard Operating Procedures (SOPs).
  - Develop a plan for environmental compliance e.g., NEPA, Hazardous Wastes.
  - Establish Job Hazard Analyses (JHA). See sidebar on page 37.
  - Identify specific training requirements e.g., safety, internet technology (IT).
  - Ascertain infrastructure support capacity and needs e.g., vessel operations, IT, equipment and instrumentation.
- Results:
  - Internalize the end game by identifying what success/progress looks like (that is measurable) upfront in the planning phase.
  - Establish a baseline by which to compare progress by looking at past performance results.

Do – Conduct

*The **do** phase in the QMA cycle relates to the **conduct** of projects/programs during which the following elements are addressed under each of the Baldrige Criteria:*

- Leadership
  - Approve and facilitate execution of the plan (including allocation of resources) and SOPs.
  - Ensure that research activities proceed in alignment with GLERL's strategic plan as well as organi-

zational business practices and regulatory requirements, such as safety practices, environmental compliance, and NOAA's directive on Public Access of Research Results (PARR).

- Strategic Planning
  - Guide the conduct of project/program implementation in accordance with approved plans e.g., strategic plan, AOP, Scope of Work, SOPs, including resource allocations.
  - Details of approved project plan (personnel time allocations, budget, etc.) are in alignment with the strategic plan and presented/communicated to the workforce and executed.
  - Provide process to strategically manage project-related changes and to document changes to the plan accordingly.
- Customer Focus
  - Continue building relationships with internal and external customers, in accordance with the strategic plan.
  - Target communication to customers on the progress of project activities.
- Measurement, analysis, and knowledge management
  - Implement components of data management plans e.g., metadata, organization, workflow from collection to archiving and access, data sharing.
  - Capture outputs, such as experimental results, data analysis, model outputs, publications, among others.
  - Track and compile performance measures/results.
- Workforce Focus
  - Communicate and execute a transparent staffing plan and hiring process.
  - Support and execute IDPs to advance careers.
  - Promote engagement among colleagues and supervisors to provide opportunities for input and feedback on project/program activities as well as internal processes.
  - Foster an inclusive culture (one GLERL) that maintains internal communication on relevant issues.
  - Ensure that the workforce contribution to GLERL's mission is documented, recognized, and understood.
- Operations Focus
  - Conduct research projects and product development that is efficiently supported by infrastructure e.g., vessels, laboratory equipment/instrumentation, safety training, procurements, efficient business practices.
  - Apply project review and approval process that is consistent.
  - Conduct work with continual improvement and organizational excellence as core values.
- Results
  - Monitor progress on a project level utilizing the AOP quarterly reporting.

Check – Assess and Evaluate

*The **check** phase in the QMA cycle involves **assessing and evaluating** the execution of projects and internal processes based on outputs and outcomes. During the check stage, the following elements are addressed under each of the Baldrige Criteria:*

- Leadership
  - Hold quarterly progress report meetings.
  - Evaluate progress toward meeting program/project goals, objectives, and milestones.

- Strategic Planning
  - Establish and use infrastructure tool(s) for reporting.
  - Compare project implementation with the approved strategic plan and the delineated outputs/outcomes and evaluate based on milestones/metrics.
  - Identify areas where changes are needed.
  - Identify external drivers which have impacted success and the need for course corrections.
- Customer Focus
  - Evaluate customer satisfaction with the conduct of projects/programs.
- Measurement, analysis, and knowledge management:
  - Identify successes and challenges (i.e., lessons learned that will be applied to adjust and improve projects/programs) during evaluation cycles throughout the project/program year.
  - Document and report on lessons learned in order to capture opportunities for communication to internal and external customers.
  - Check for implementation of data management plans.
- Workforce Focus
  - Review engagement of workforce and their satisfaction level on how the projects/programs are progressing.
  - Assess compliance on issues related to workforce safety, environmental compliance, security, data management, among others.
  - Ensure professional development goals are being supported and met.
- Operations Focus
  - Identify opportunities for innovative improvements to advance organizational excellence in the execution of work.
  - Evaluate quality of products and efficiency of processes.
  - Assess compliance e.g., NEPA, Hazards, Administrative Rules, Small Boat Risk Assessments.
- Results
  - Compare performance results to performance measures.

Act – Inform/Modify

During the ***act*** *phase, decisions are* ***informed*** *(based on lessons learned) and* ***modifications*** *are made to the priorities, goals, and research questions that drive the design and execution of project/programs; the following elements are addressed under each of the Baldrige Criteria.*

- Leadership
  - Based on assessment/evaluation, make adjustments, if necessary, to ensure fair and equitable distribution/use of resources to further advance or, if necessary, modify priorities.
  - Use evidence-based decisions to inform adaptations in project goals to ensure sustainability of GLERL projects/programs going forward.
- Strategic Planning
  - Address strategic challenges encountered during the AOP process.
  - Position GLERL with the capacity – informed by decision-making – to make course corrections of projects/programs through modifications to strategic plan priorities, goals, research questions, and overall project design.
  - Embed organizational agility and flexibility based on evaluation outcomes (to reduce the need for course corrections next project cycle).

- Customer Focus
  - Take into account the voice of the customer and customer satisfaction for the next project/program cycle, including business practices.
  - Revisit internal and external customer needs (e.g., regulatory entities, stakeholders, headquarters, researchers, supervisors, etc.), including consideration of new customers.
- Measurement, Analysis, and Knowledge Management
  - Revisit/adjust performance measures/desired outcomes.
  - Identify and apply support tools needed for continual improvement (e.g., program management templates, IT support for data management, informational services tracking tools).
- Workforce Focus
  - Reposition workforce for success, based on outcomes from assessment/evaluation in the check step.
  - Adjust engagement opportunities and feedback loop mechanism based on staff evaluation of the internal communications processes.
  - Recognize staff via promotions and awards following performance review.
  - Adjust resource/staff allocations and enhance professional capacity.
- Operations Focus
  - Advance continual improvement and operational excellence as core values in the execution of work.
  - Create opportunity for innovation through the act phase.
  - Make improvements to products, services, and processes based on project review, evaluation outcomes and lessons learned.
  - Promote organizational success and sustainability based on lessons learned.
- Results
  - Celebrate successes and address gaps and unmet needs.
  - Maintain support needed to sustain successes.
  - Redirect efforts to address gaps in results.
  - Adjust and improve program efforts based on lessons learned.

Safety and Environmental Compliance

Integral to quality management at GLERL is the health and safety of the workforce, including federal employees, co-located cooperative institute staff and other NOAA partners, contractors, student fellows, etc. In GLERL's commitment to conducting its mission with organizational excellence, it is a priority to provide a workplace environment free of known hazards that could pose unacceptable health and safety risks or cause injury to employees. In addition, environmental compliance must be practiced at GLERL, such that the effects of research and operational activities do not negatively impact the quality of the environment. On an organizational level, safety and environmental compliance are key considerations at GLERL during strategic planning, AOP development, and individual project design, implementation, and review. It is critical that GLERL's research and operations activities are conducted in accordance with all federal/state permits and requirements related to safety and environmental compliance.

To further advance organizational excellence at GLERL, the Baldrige Criteria are applied in addressing health and safety and environmental compliance program elements as part of the quality management PDCA system.

Safety and Environmental Compliance (SEC) Quality Cycle Integrating Baldrige Criteria

To promote health and safety, GLERL is using OSHA's Injury and Illness Prevention Program (IPP)[6] best practice guidance. The IPP program is based on the premise that accident prevention is of primary importance in all phases and levels of operation and administration. Additionally, on an individual level, employees are expected to be aware of safety and environmental compliance rules and procedures, and to take corrective action to address unsafe conditions and unsafe acts within their control. If conditions are beyond the employee's control, steps must be taken to bring the issue to the attention of their supervisor and/or project leader. GLERL's QSEC program lead and GLERL managers must ensure that programs, procedures, and training systems are in place to protect their employees and the environment.

The following health and safety programs, among others, have been established at GLERL in accordance with OSHA's best practices and are available on GLERL's Health and Safety intranet website:

- Chemical Hygiene Plan
- Hazard Communication Plan
- Fall Protection Program
- GLERL/Lake Michigan Field Station Respiratory Protection Program
- GLERL Job Hazard Analysis (See side bar) Ann Arbor/Lake Michigan Field Station Occupant Emergency Plan

Environmental compliance at GLERL is driven by state and federal regulations applicable to GLERL's activities. A primary focus is the implementation of the National Environmental Policy Act (NEPA). The Act provides a mandate and framework for federal agencies to consider all reasonably foreseeable environmental effects of proposed actions and to involve and inform the public in the decision-making process. More specifically, NEPA relates to potential effects of agency activities on endangered species, marine mammals, fisheries, habitat restoration, land acquisition, construction projects, or research programs. NOAA's NEPA policy[7] focuses on the following:

- Fully integrate NEPA into organizational planning and decision-making process.
- Fully consider the impacts of NOAA's proposed actions on the quality of the environment.

Job Hazard Analysis

To perform a job hazard analysis (JHA), the supervisor, branch chief, marine superintendent, or PI will use the JHA Worksheet and Certification of Hazard Assessment form and follow the directions below:

1) Select a job to be analyzed. Priority should be given to those with the most risk. 2) Engage the employee(s) who will perform the job in the JHA process. 3) Break the job down into successive steps. 4) For each step, identify potential hazards, unsafe acts, or unsafe conditions associated with each step with consideration for the following:

- *What are the past incidents associated with similar tasks*
- *Can the employee strike against, or be struck by, caught in, on or between anything?*
- *Can the employee fall, become overexerted, or be exposed to anything injurious?*
- *What is the time frame and location of work to be performed?*
- *Material handling aspects?*
- *Environmental factors (e.g. driving/lake conditions)?*

5) Recommend an action or procedure to address the identified potential hazards associated with each step. This would include instructions for: use of ventilation, personal protective equipment, etc. 6) Document the details of steps 3, 4, and 5 on the JHA Worksheet and Certification of Hazard Assessment Form and complete the remaining sections of the form. 7) Submit the completed JHA Worksheet form to the safety committee chair, who will convene a meeting committee meeting, if needed. 8) Members of the safety committee will review the JHA Worksheet and the chair will work with the originator to make any necessary changes to the job and/or the form. 9) The safety committee chair will post the finalized JHA Worksheet form on the GLERL Safety Web Page as a training tool and job performance reference. 10) A review of existing JHAs will be performed, as deemed appropriate.

6 For further information on OSHA's Injury and Illness Prevention Program, see following U.S. Dept. of Labor websites: https://www.osha.gov/dsg/InjuryIllnessPreventionProgramsWhitePaper.html and https://www.osha.gov/dsg/topics/safetyhealth

7 NOAA Office of General Council, National Environmental Policy Act website: http://www.nepa.noaa.gov

- Involve interested and affected agencies, governments, organizations, and the public early in planning and decision-making processes when proposed federal actions could potentially impact environmental quality.
- Conduct and document environmental reviews and related decisions appropriately and efficiently.

A Categorical Exclusion (CE) under NEPA is a list of actions an agency has determined "do not individually or cumulatively affect the quality of the human environment (40 C.F.R. §1508.4)." If a proposed action is included in an agency's CE, the agency must ensure that no extraordinary circumstances might cause the proposed action to affect the environment. Extraordinary circumstances include effects on endangered species, protected cultural sites, and wetlands. If the proposed action is not included in the description provided in the CE, an Environmental Assessment must be prepared. At GLERL, a CE memo has been established to define the GLERL activities categorically excluded: computer modeling, planning, budgeting, and administration which are consistent with the category description in general for which the potential environmental effects are minor or negligible. Other environmental programs being followed at GLERL include Hazardous Waste Management and Universal Waste Management.

Definition of Categorical Exclusion under NEPA

By regulatory definition (40 CFR 1508.4) Categorical Exclusion means "a category of actions which do not individually or collectively have a significant effect on the human environment and which have been found to have no such effect in procedures adopted by a Federal agency in implementation of these regulations (Sec. 1507.3) and for which, therefore, neither an environmental assessment nor an environmental impact statement is required.

QSEC Paths and Related Milestones (2016-2020)

Quality Management

Goal

1. The quality of work in areas of research and operations is assured in the conduct of all GLERL activities.

Path	Milestones
A. Develop a quality management approach using the *Baldrige Performance Excellence Program.*	• Complete GLERL's quality management plan and socialize/implement the plan through strategic planning and the AOP process. • Resurvey GLERL staff to measure progress in the priority areas of concern identified in the Baldrige Survey, "Are We Making Progress?"
B. Develop and implement procedures to respond to priority areas of concern identified in responses to the Baldrige survey, "Are We Making Progress?"	

Safety and Environmental Compliance

Goal

2. A safe workplace is promoted for the GLERL workforce.

Path	Milestones
A. Develop a policy statement on GLERL's safety program.	• Establish an Injury and Illness Prevention Plan (IIPP) to formally address the goal of zero recordable injuries/illnesses and annual injury rate reductions under OSHA guidelines, including the development of additional JHAs (see sidebar on page 37). • Communicate/promote the components of the approved IIPP. • Implement the IIPP.
B. Secure approval from leadership for the policy statement on safety and environmental compliance.	
C. Communicate/promote the approved safety policy statement to the GLERL workforce.	
D. Implement the safety policy.	

Goal

3. Environmental compliance is practiced in the conduct of all research and operational activities at GLERL

Path	Milestones
A. Ensure that an up-to-date research project plan is in place for each science branch by the end of the first quarter of each fiscal year.	• Categorical Exclusion worksheets are submitted, as necessary, by the scientists as part of the research project planning phase. • Zero regulatory notices of violations related to NOAA compliance standards. • All internal research projects proposed go through a NEPA review. • Hazardous waste stream generation is considered and addressed when PIs develop research projects plans during the AOP process.
B. Address environmental compliance issues (e.g., NEPA, and hazardous wastes) by using PDCA Quality Management Approach during the AOP process.	

Data Management

A Framework for GLERL's Data Management Plan

Purpose and Background

The future of data management at NOAA's Great Lakes Environmental Research Laboratory (GLERL) is, in large part, being driven by federal policy to increase Public Access to Research Results (PARR). The PARR was established in response to the 2013 memorandum from the White House Office of Science and Technology Policy (OSTP) which directs federal agencies to increase public accessibility of digital data and publications produced by federal researchers or by recipients of federal funds.[1]

The following basic principles generally apply to NOAA environmental data (as defined by NOAA Administrative Order (NAO) 212-15, see sidebar), though there may be exceptions for particular datasets on a case-by-case basis.[2]

- Full and Open Access: NOAA data should be made fully and openly available to all users promptly, in a non-discriminatory manner, and free of charge (or at minimum cost).
- Long-Term Preservation: NOAA data should be managed as an asset and preserved for future use
- Information Quality: NOAA data should be well documented and of known quality.
- Ease of Use: NOAA observations should be transformed into relevant products for end users that are made discoverable and accessible online using interoperable services and standardized formats to encourage the broadest possible use.

> **Environmental Data:** *is defined by NOAA "as recorded and derived observations and measurements of the physical, chemical, biological, geological, and geophysical properties and conditions of the oceans, atmosphere, space environment, sun, and solid earth, as well as correlative data, such as socioeconomic data, related documentation, and metadata."*

There are additional NOAA data management directives that play a role in GLERL's data management planning (see sidebar on the following page).

Goal: Stewardship of GLERL data that serves GLERL staff and customers based on a coordinated data management plan, and is compliant with NOAA's plan for Public Access to Research Results (PARR).

To attain GLERL's goal on data management, it is essential that data at GLERL is systemically compliant with NOAA data polices and supports metadata standards. It is also necessary to provide skilled personnel and sufficient funding for data management, including electronic archiving. The data—representing a significant taxpayer investment—must be accessible to the public for long-term use in monitoring, understanding and predicting Great Lakes physical and ecological changes.

Currently, GLERL disseminates data and related products to the public by the following avenues:

- GLERL Publications (www.glerl.noaa.gov/pubs)
- GLERL Technical Reports (www.glerl.noaa.gov/pubs/#techRep)
- GLERL's Products and Data website (www.glerl.noaa.gov/data).

As GLERL moves forward in data management planning that is in compliance with the PARR, several challenges must be addressed regarding historical and new data. An overall challenge is the heterogeneous data sets generated from GLERL's diverse research portfolio. Since GLERL's inception, the research questions have been constantly evolving, which encompass diverse, complex, and in some cases, unique physical, chemical, and biological data not available from other sources. For historical data, the strategy is to system-

1 Memorandum for the Heads of Executive Departments and Agencies. Feb. 22, 2013. From John P. Holdren Director, Office of Science and Technology; Subject: Increasing Access to the Results of Federally Funded Scientific Research

2 NOAA's Environmental Data Framework (pages 7-8). March 14, 2013.

atically catalogue, the backlog of datasets, which is particularly difficult given the retirement of several scientists who served as project leaders. In some cases, the documentation of quality control and the metadata during the research process was incomplete. GLERL's new data is generated from a wide array of observing technology, computer modeling, and scientific analysis—ranging from raw to highly processed and quality controlled data. Particularly challenging is the management of biological data given that it typically takes at least two years from collection, analysis, and interpretation in making them publicly available. A range of issues (from archiving historical data sets to collecting new data sets) will need to be addressed in a coordinated data management plan.

NOAA's Data Management Directives

- *Data Management Planning*
- *Data Access*
- *Data Documentation*
- *Data Citation*
- *NOAA Procedure for Scientific Records Appraisal*
- *Data and Publication Sharing Directive for NOAA Grants, Cooperative Agreements, and Contracts*

To begin the process of compiling and integrating the component parts of GLERL's data management plan, leadership has convened a data management planning (DMP) committee to develop a concept plan for data management. The team is comprised of a cross-cut of principal investigators, IT manager, quality assurance lead, web developer, data architect, and communications/outreach specialist.

The following objectives and milestones of this framework have been recommended by the DMP committee as the basis for the concept plan in alignment with GLERL's five-year strategic plan.

Objective

2016 - Develop a data management concept plan, led by the data management committee.

Milestones

- Hold regular meetings of the DMP committee to complete the development of a data management concept plan and identify required actions.
- Identify formal roles of staff (e.g., data collectors, data stewards, standards experts) and their responsibilities related to data management throughout the organization. Integrate these new data management roles/ responsibilities in position descriptions and performance standards.
- Develop a position description (PD) for an IT Specialist (Data Manager/Spatial Analyst).
- Conduct training sessions for project leads and data collectors on data management and meta data requirement.
- Begin to centralize and catalogue historical datasets and create metadata data.

Objective

2017 - Initiate implementation of the concept plan with a focus on building capacity for data management on an organizational and project specific level.

Milestones

- Hire IT specialist (Data Manager/Spatial Analyst).
- Continue work with project leads in developing project-specific data management and storage. plans for each research project.
- Develop workflow to process and archive data to appropriate national data centers e.g., National Centers for Environmental Information (NCEI).
- Ensure that 25% of historical datasets are cataloged with metadata.
- Begin Quality Assurance/Quality Control (QA/QC) work on FY16 field data.

Objective

2018 - Continue implementation of concept plan to ensure that GLERL is equipped with expertise, staff, and infrastructure needed to effectively support data management activities.

Milestones

- Assess staffing capabilities to determine if needs are being met by data management plan and associated team.
- Implement and assess the data management and storage plans for existing projects.
- Maintain connections with national data centers (i.e., NCEI) to implement and assess the workflow to process and transfer data.
- Ensure that 50% of historical datasets are cataloged with metadata.

Objective

2019 - Complete full assessment and evaluation of the effectiveness of GLERL's DMP concept plan and its implementation.

Milestones

- Maintain work delineated in FY18.
- Conduct a full assessment/evaluation of the effectiveness of the different elements of GLERL's DMP.
- Ensure that 75% of historical datasets are cataloged with metadata.
- Ensure that 50% of newly collected data (since 2016) is compliant with the NOAA environmental data directive.

Objective

2020 - Adjust the DMP based on outcomes of assessment and evaluation.

Milestones

- Ensure that 100% of datasets generated during FY16-19 are compliant with the NOAA Data Access Procedural Directive and the NOAA Data Documentation Procedural Directive (see sidebar on previous page: NOAA's Data Management Directives).
- Ensure that 100% of historical datasets are catalogue with metadata.
- Implement adjustments identified as feasible with available resources by assessments made in FY19.

Succession Plan: 2016 - 2020

GLERL's succession plan provides guidance for staffing over the period of 2016-2020. The plan, last updated in 2014, reflects final actions required to complete the laboratory's re-organization and to address immediate staffing needs. The 2014 plan has been fully implemented with all recruitment actions in progress or completed. The current organization of GLERL and associated positions are shown in Figure 1.

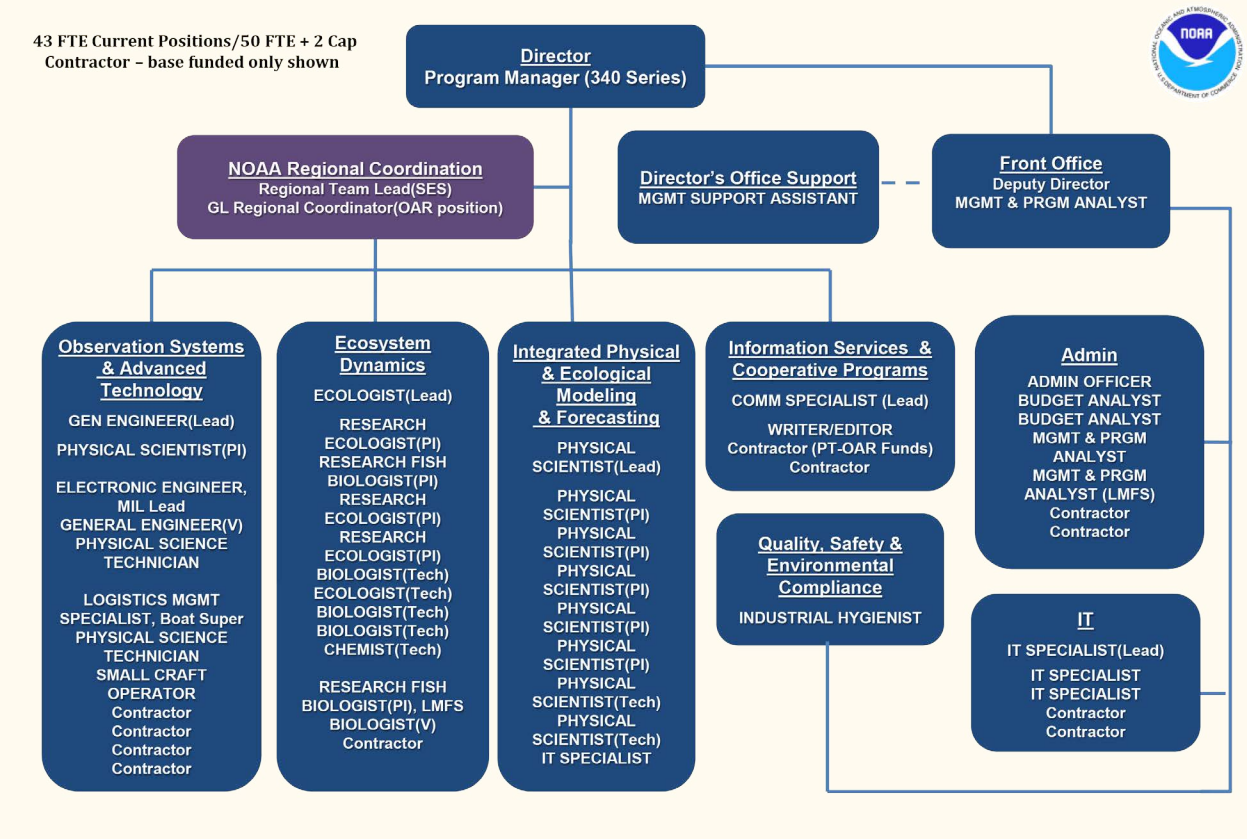


Figure 1: GLERL current positions and organization based on 2014 staffing plan

Presently, GLERL has 43 current federal full-time-equivalent (FTE) positions. In mid-2015, NOAA OAR re-assessed its cap on federal positions for all laboratories and programs and GLERL was allotted a cap of 50 FTE plus 2 reimbursable positions. In 2015, the total base cost per year of the federal salaries plus contract costs was $6,151,300 per year.

Considering the constraints of the new FTE cap and expected level base funding, as well as expected retirements in critical positions within the next 5 years, GLERL leadership has identified the need for a new staffing plan as part of the 2016-2020 Strategic Plan. In September and October of 2015, input on staffing needs was solicited from GLERL's four branches as well as from the following infrastructure teams: Administrative Services; Information Technology; and Quality, Safety and Environmental Compliance. The input was received, summarized and presented on October 15 to the branch and team leads, with Union representation present. Initial discussions were conducted on staffing plan alternatives. A second meeting took place on October 29 to resolve remaining questions, further consider alternatives, and finalize a proposed plan. One additional discussion took place amongst the science branch chiefs to confirm the proposed new positions.

The following guiding principles were provided as the basis of the staffing plan discussions:

- Balance staffing across branches.

- Prioritize staff positions based on the following criteria:
    - Meet cross-branch needs.
    - Address gaps in science/service.
    - Enable NOAA priority missions:
        - Ecosystem Forecasting Roadmap (Resiliency).
        - National Water Center (Evolve NWS).
        - Invest in Observational Infrastructure.
        - Accelerates Research to Operations (Organizational Excellence).

The set of parameters used to guide the discussions included:

- Set the starting point for today looking to the future.
- Base decisions on positions not people.
- Develop plan through consensus.
- Recognize of the following constraints:
    - FTE cap (50 base + 2 reimbursable).
    - Base Funding.
- Consider only GLERL base-funded federal permanent positions:
    - Affordable new positions.
    - Converting contract to federal positions.
    - Re-classifying existing positions.

It was further emphasized that any new plan would have no adverse action on existing positions and reorganization was not being considered as this time.

As a result of meetings between each of GLERL's branches, the following positions were proposed:

Observation Systems and Advanced Technology

- Add Vessel Operations Marine Technician (focus on instrumentation Operations and Maintenance) – reclassify existing Physical Science Technician position via accretion of duties.
- Add Vessel Operations Vessel Captain/Marine Diesel Mechanic (new position).
- Reclassify Small Craft Operator to Physical Science Technician.
- Add Advanced Technology Engineering Principal Investigator (PI) (year-round under-ice observations—new position).
- Add Satellite Remote Sensing Principal Investigator (succession planning for existing position).

Ecosystem Dynamics

- Add MOCNESS and Larval Fish Tech (new position).
- Add Experimental Field Tech with radioisotope skills (reclassification of existing position).
- Add Nutrients Tech with radioisotope skills optional (reclassification of existing position).
- Add Data Tech (could be cross-branch—new position)
- Add Primary Production /Microzooplankton to fill gap in foodweb team (PI—new position).
- Add Biophysical Modeler (PI) (could be cross-branch—new position).

Integrated Physical and Ecological Modeling and Forecasting

- Add Atmospheric/Coupled Modeler (support).
- Add Observational Oceanographer (PI) (could be cross-branch—new position).
- Add Ice Analysis and Modeling position (support—reclassification of existing position).

- Add Probabilistic Nutrient Modeler (support—new position).
- Add Watershed Hydrology Modeler (PI).
- Add Hydraulics Modeler (PI).
- Add Atmospheric Modeler at Weather Scales (PI).
- Add GIS/Data Management Tech (cross-branch —new position).
- Add Biophysical Modeler (PI) (could be cross branch—new position).
- Add Web Developer/Programmer (cross branch—new position).
- Add Wave Modeler for FVCOM coupling (new position).

It was noted during the discussion that the Watershed Hydrology Modeler and Hydraulics Modeler could potentially be combined into one technical support position.

Information Services and Cooperative Programs

- Part-time Graphic Designer (contract)
- Program Specialist (contract)

It was noted during the discussion that although these positions are already in place, it would be desirable to convert them to one full-time federal position, if possible.

Quality, Safety and Environmental Compliance (QSEC)

- QSEC Part-time Support position:
    - at Lake Michigan Field Stations (LMFS).
    - at GLERL.

Discussion centered on whether this staff need could be met through a student, CILER, student federal position, or through the Veterans Rehabilitation Vocational Program.

Information Technology

- IT Specialist (convert HPC contract position to federal position).
- IT Specialist (convert Mission Support contract position to federal position).

It was noted that cost efficiencies could be gained in the interim by moving these two positions under one contract agency and that the Mission Support position could initially be a Pathways Student position leading to a permanent full-time position.

Administrative Services and Executive Office Support

- Reclassify Budget Analyst to Acquisition Specialist (DPA/COR).
- Front Office Administrative Assistant positions (convert the two contractors to federal positions).
- Reclassify Executive Office Management Support position to Program Management.

Following presentation and discussion of staff input from each branch and infrastructure team, it was recognized that the needs delineated for FTE positions far exceeded the authorized FTE cap and available base funding required in support of the positions. To help address this situation, it was note that converting several of the contract positions to federal positions (identified positions were federal prior to the last hiring freeze) would yield significant cost savings, and would free base funding for maximizing the proposed new federal positions.

Discussion then turned to identifying new positions that filled cross-branch needs to maximize the benefit of allocating the limited FTEs. These positions were identified as:

- Biophysical Modeler
- GIS/Data Manager

- Web Developer/Programmer
- Observational Oceanographer/Advanced Technology Engineering

Through the course of the discussion, the need was recognized for GLERL to achieve compliance with Federal Executive and NOAA Administrative Orders on managing its data as an asset. Compliance is becoming more urgent and compelling as staff managing large and important data sets retire or approach retirement. Filling a position of Data Manager was considered an essential first step, but additional roles and responsibilities would need to be distributed among existing positions. Development of a data management plan to address data management administration, information technology, data documentation and data publication is provided in the 2016-2020 Strategic Plan (Appendix G; currently in progress).

A final alternative staffing plan was achieved by consensus of the group (director, deputy director, branch chiefs, team leaders and Union representative) that is presented below.

- Contractors previously identified for conversion, converted to federal permanent positions
    - Administrative Services Team – two front office Administrative Assistants
    - Information Technology Team – two IT Specialists
- Reclassification of four positions
    - Administrative Services Team – Budget Analyst to DPA/COR
    - Executive Office – Management Support Assistant to Program Manager
    - OSAT – Physical Science Technician to Vessel Operations Marine Technician
    - OSAT – Small Craft Operator to Physical Science Technician
- 3 new positions added
    - Ecosytem Dynamics - Coupled Biophysical Modeler
    - IPEMF - GIS/Data Manager
    - Information Technology - Web Developer/Programmer
- 50 FTE Total
- Total base cost per year = $6,295,600

The plan will add three new positions while only increasing costs by $144,300, thus remaining under the 50 FTE +2 Reimbursable cap. The new proposed staffing plan is shown in Figure 2.

Succession planning will be addressed through two approaches:

- Create CILER student positions for technicians and support staff funded from base projects, anticipated and built into fiscal year annual operating plans.
- Use Pathways Program as appropriate, requesting over-hire FTEs for Pathways Students.

The two reimbursable positions will be determined based upon funding received from anticipated reimbursable projects:

- Chief Scientist's FY17 R2X Program
- Integrated Water Prediction FY17-FY18
- GLRI
- Climate Program Office
- Other

At present, the two reimbursable positions are being fully utilized by existing projects. Additional reimbursable positions will be requested on an as needed basis, dependent upon approval.

Execution of GLERL's Succession Plan for 2016-20 is currently moving forward, guided by discussion with Work Force Management in partnership with GLERL's Union.

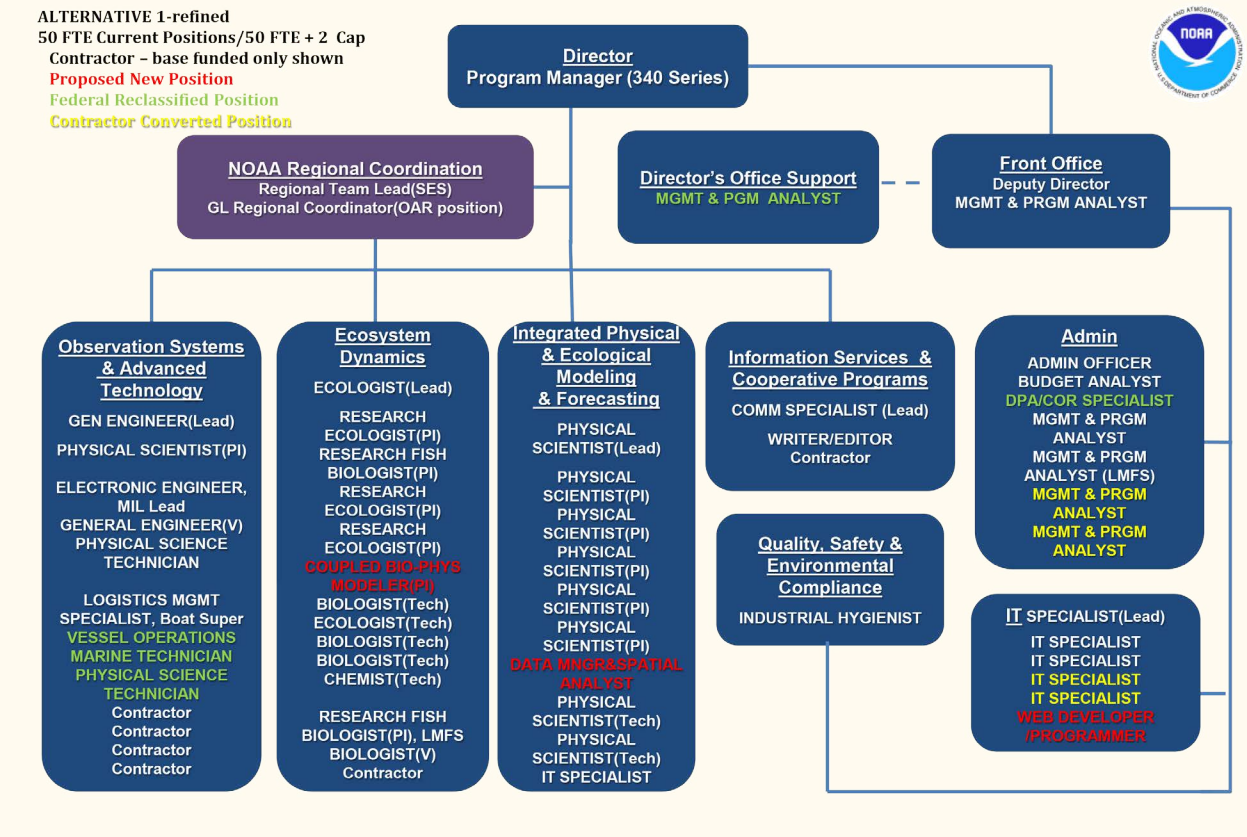


Figure 2: GLERL staffing plan proposed for 2016-2020.

Lifecycle Management of Critical Equipment

GLERL takes a lifecycle management approach to plan in the near and long term for new costs, and to identify emerging needs as well as obsolete equipment. In the conduct of scientific research, GLERL's depends on numerous pieces of equipment, many of them state-of-the-art. Lifecycle management of GLERL's critical equipment involves maintaining a list of equipment valued at ≥ $10,000, maintaining the equipment for the life of each item, and planning for funds to replace equipment as needed. In the document below, the value and replacement costs of GLERL's critical equipment is listed to assist leadership in projecting costs to maintain GLERL's equipment in efforts to ensure uninterrupted conduct of GLERL research.

Any requirement $150,000 and over will have to be recorded in the Federal Advance Acquisition Plan (FAAPs) system. A FAAPs number is required on the Purchase Request in the CRequest system. Each year, FAAPs information for the next fiscal year is due by the end of May. Any action entered into FAAPS after May 31 is considered an unplanned action

Below is a summary of the monetary value of GLERL's critical equipment, expected replacement costs, and purchase price for wish list items.

Current equipment		Wish list (numbers below don't include replacement costs, only initial cost)	
Total current value (including vessels)	$14,113,576	Purchase in <5 years	$563,000
Equipment due for replacement in <5 years	$15,782,130	Purchase in 5-10 years	$2,017,600
Equipment due for replacement in 5-10 years	$19,735,776	Purchase in >10 years	$2,556,600
Equipment due for replacement in >10 years	$32,363,526		

Initial Replacement Date	*Subequent Replacement Schedule*	*Corrected description*	*Asset Value*	*Replacement, Overhaul (vessels only), or First-Time Purchase Cost*
Annually	replace every < 5 years	Backup Server Software	13,280.00	$13,000
< 5 years	replace every < 5 years	Fluoroprobe	26,860.50	$35,000
< 5 years	replace every < 5 years	Fluoroprobe	24,891.30	$35,000
< 5 years	replace every < 5 years	Environmental Sample Processor accessories (including pressure housing, mooring/telecoms, deployment base, and pucks)	150,000.00	$200,000
< 5 years	replace every < 5 years	Virtual Host	$25,000	$25,000
< 5 years	replace every < 5 years	Virtual Host (2nd)	$25,000	$25,000
< 5 years	replace every < 5 years	Cluster data node - Rhino	102,338.90	$120,000
< 5 years	replace every < 5 years	Tape and disk storage for backup	50,000.00	$70,000
< 5 years	replace every < 5 years	Network equipment (switches, outside-world connectivity)	40,000.00	$30,000
< 5 years	replace every < 5 years	Bundle - IT hardware needed (computers, etc.) - Replacement plan now in place (according to Brad)	150,000.00	$194,000
< 5 years	replace every < 5 years	Cluster data node - Bear	102,338.90	$60,000
< 5 years	replace every < 5 years	Storage for general use	60,000.00	$60,000
< 5 years	replace every 5-10 years	Incubator, Laboratory	10,245.00	$12,000
< 5 years	replace every 5-10 years	Phytocyt Flow Cytometer	39,000	$200,000
< 5 years	replace every 5-10 years	Real Time PCR-System 7500	45,908.00	$100,000
< 5 years	replace every 5-10 years	Laser optical plankton counter	50,298.00	$50,000
< 5 years	replace every 5-10 years	Benchtop fluorometer	15,345.53	$15,000
< 5 years	replace every 5-10 years	Benchtop fluorometer	15,345.53	$15,000
< 5 years	replace every 5-10 years	Phone system	62,287.40	$80,000
< 5 years	replace every 5-10 years	Video teleconferencing equipment	20,982.98	$20,000
< 5 years	replace every 5-10 years	Conference room equipment (bundle). Small conference rooms (4 rooms, including LMFS) $2000, Mich-Huron $7500, and Superior $120K	$135,500	$135,500
< 5 years	replace every 5-10 years	HAB Buoys	$25,000	$25,000
< 5 years	replace every 5-10 years	HAB Buoys	$25,000	$25,000
< 5 years	replace every 5-10 years	HAB Buoys	$25,000	$25,000
< 5 years	replace every 5-10 years	HAB Buoys	$25,000	$25,000
< 5 years	replace every 5-10 years	YSI EXO2	$20,000	$20,000
< 5 years	replace every 5-10 years	YSI EXO2	$20,000	$20,000
< 5 years	replace every 5-10 years	YSI EXO2	$20,000	$20,000
< 5 years	replace every 5-10 years	YSI EXO2	$20,000	$20,000
< 5 years	replace every 5-10 years	YSI EXO2	$20,000	$20,000
< 5 years	replace every 5-10 years	YSI EXO2	$20,000	$20,000
< 5 years	replace every 5-10 years	YSI EXO2	$20,000	$20,000
< 5 years	replace every 5-10 years	YSI EXO2	$20,000	$20,000
< 5 years	replace every 5-10 years	YSI EXO2	$20,000	$20,000
< 5 years	replace every 5-10 years	Camera, towed	25,000.00	$30,000

< 5 years	replace every 5-10 years	Buoy	50,000.00	$70,000
< 5 years	replace every 5-10 years	Buoy	50,000.00	$70,000
< 5 years	replace every 5-10 years	Buoy	50,000.00	$70,000
< 5 years	replace every 5-10 years	Buoy	50,000.00	$70,000
< 5 years	replace every 5-10 years	Buoy	11,380.00	$11,380
< 5 years	replace every 5-10 years	ADCP	22,135.00	$25,000
< 5 years	replace every 5-10 years	ADCP	22,135.00	$25,000
< 5 years	replace every 5-10 years	ADCP	23,388.60	$25,000
< 5 years	replace every 5-10 years	ADCP	28,933.40	$25,000
< 5 years	replace every 5-10 years	ADCP	28,933.40	$25,000
< 5 years	replace every 5-10 years	ADCP	28,093.40	$25,000
< 5 years	replace every 5-10 years	ADCP	18,343.75	$25,000
< 5 years	replace every 5-10 years	ADCP	18,343.75	$25,000
< 5 years	replace every 5-10 years	ADCP	17,850.00	$25,000
< 5 years	replace every 5-10 years	Radiometer profiler (AOP)	42,895.25	$43,000
< 5 years	replace every 5-10 years	Radiometer downwelling irradiance sensor	10,433.75	$30,000
< 5 years	replace every 5-10 years	Telephone, Satellite	12,246.70	$12,250
< 5 years	replace every 5-10 years	IOP Sensor	24,956.90	$25,000
< 5 years	replace every 5-10 years	Short-range ADCP	13,018.00	$15,000
< 5 years	replace every 5-10 years	ADCP	25,398.49	$20,000
< 5 years	replace every 5-10 years	Two Frequency Fisheries Acoustics	75,799.34	$75,000
< 5 years	replace every 5-10 years	Single frequency 70 kHz fisheries acoustics	95,000.00	$95,000
< 5 years	replace every > 10 years	CHN analyzer	41,100.00	$35,000
< 5 years	replace every > 10 years	R2604, RV No Name (status=active), Class II	160,000	$22,000
< 5 years	replace every > 10 years	R8001, RV LAURENTIAN (status=active), Class SRV	6,000,000	$12,000,000
< 5 years	replace every > 10 years	R5002, RV Storm, (status=active), Class III	1,100,000	$85,000
< 5 years	replace every > 10 years	R5501, RV No Name (status=active), Class III	1,400,000	$85,000
5-10 years	replace every 5-10 years	Environmental Sample Processor 2G	179,400.00	$179,400
5-10 years	replace every 5-10 years	Upright microscope	87,162.12	$100,000
5-10 years	replace every 5-10 years	FlowCAM	94,015.00	$150,000
5-10 years	replace every 5-10 years	Fast-repeition rate fluorometer	25,576.50	$30,000
5-10 years	replace every 5-10 years	UV Radiometer	19,995.00	$20,000
5-10 years	replace every 5-10 years	UV Radiometer surface sensor	10,995.00	$11,000
5-10 years	replace every 5-10 years	Plankton Survey System (subtracted 50K from the total cost of this item because it is already accounted for in laser plankton counter)	100,000	$100,000
5-10 years	replace every 5-10 years	Phyto-Pam	32,000	$35,000
5-10 years	replace every 5-10 years	Nutrient analyzer	46,526.00	$70,000
5-10 years	replace every 5-10 years	Digital camera for microscope	11,980.72	11, 000
5-10 years	replace every 5-10 years	-80 freezer	10,465.00	$25,000

5-10 years	replace every 5-10 years	Digital PCR System	42,115.87	$100,000
5-10 years	replace every 5-10 years	Core System Loader	42,115.87	$42,000
5-10 years	replace every 5-10 years	Mocness underwater unit	15,000.00	15,000.00
5-10 years	replace every 5-10 years	Mocness strobes	18,000.00	18,000.00
5-10 years	replace every 5-10 years	Mocness nets	10,000.00	10,000.00
5-10 years	replace every 5-10 years	Benchtop fluorometer	15,345.53	$15,000
5-10 years	replace every 5-10 years	Signal generator	14,758.16	$15,000
5-10 years	replace every 5-10 years	Signal generator	42,037.00	$40,000
5-10 years	replace every 5-10 years	Suna-N nitrate sensor	$25,000	$25,000
5-10 years	replace every 5-10 years	Suna-N nitrate sensor	$25,000	$25,000
5-10 years	replace every 5-10 years	IOP Sensor	28,509.25	$30,000
5-10 years	replace every 5-10 years	Single-point ocean current meter	17,966.75	$15,000
5-10 years	replace every 5-10 years	YSI ADCP	14,740.00	$17,000
5-10 years	replace every 5-10 years	CTD	17,216.75	$15,000
5-10 years	replace every 5-10 years	CTD	10,138.25	$15,000
5-10 years	replace every 5-10 years	Short-range ADCP	12,558.00	$13,000
5-10 years	replace every 5-10 years	Short-range ADCP	12,558.00	$13,000
5-10 years	replace every 5-10 years	Truck, lift, fork	20,766.00	$20,766
5-10 years	replace every 5-10 years	Short-range ADCP	12,558.00	$13,000
5-10 years	replace every 5-10 years	Short-range ADCP	12,558.00	$13,000
5-10 years	replace every 5-10 years	Short-range ADCP	12,558.00	$13,000
5-10 years	replace every 5-10 years	Short-range ADCP	12,558.00	$13,000
5-10 years	replace every 5-10 years	Short-range ADCP	12,558.00	$13,000
5-10 years	replace every 5-10 years	ADCP	25,030.00	$25,000
5-10 years	replace every 5-10 years	ADCP	25,030.00	$25,000
5-10 years	replace every 5-10 years	Phosphorus sensors	12,472.25	$14,000
5-10 years	replace every 5-10 years	Phosphorus sensors	12,472.25	$14,000
5-10 years	replace every 5-10 years	ADCP	19,929.47	$25,000
5-10 years	replace every 5-10 years	ADCP	19,929.47	$25,000
5-10 years	replace every 5-10 years	CTD	10,535.75	$10,600
5-10 years	replace every 5-10 years	CTD	21,547.35	$21,000
5-10 years	replace every 5-10 years	ADCP	12,302.50	NA
5-10 years	replace every 5-10 years	Wave glider	200,000.00	200,000.00
5-10 years	replace every 5-10 years	Wave glider	200,000.00	200,000.00
5-10 years	replace every 5-10 years	Single Frequency 120 KHz Fisheries Acoustics	40,000.00	$40,000
5-10 years	replace every 5-10 years	Fisheries acoustics desk unit	15,313.34	$15,000
5-10 years	replace every > 10 years	Microscope, Inverted	87,734.54	$88,000
5-10 years	replace every > 10 years	Bomb calorimeter	20,262.87	$30,000
5-10 years	replace every > 10 years	Light microscope	39,567.43	$50,000

5-10 years	replace every > 10 years	CTD	10,068.25	$15,000
5-10 years	replace every > 10 years	Dissecting microscope	13,083.78	$13,000
5-10 years	replace every > 10 years	Mocness frame	75,750.00	60,750.00
5-10 years	replace every > 10 years	R2601, RV CYCLOPS (status=active), Class II	110,000	$10,000
5-10 years	replace every > 10 years	R2512, RV No Name (status=active), Class I	160,000	$22,000
5-10 years	replace every > 10 years	R3011, RV No Name (status=active), Class II	160,000	$22,000
5-10 years	replace every > 10 years	R4108, RV No Name (status=active), Class III	270,000	$30,000
>10 years	replace every > 10 years	Cinematography laboratory	11,699.00	$30,000
Do not replace	NA	Scanner, Document Imager	10,490.00	NA
Do not replace	NA	Hydrographic Survey Equipment	24,000	NA
Do not replace	NA	Liquid scintilation counter	29,056.00	NA
Do not replace	NA	Old optical plankton counter	18,390.00	NA
Do not replace	NA	Dissolved carbon analyzer	17,031.00	NA
Do not replace	NA	Centrifuge	14,180.50	NA
Do not replace	NA	Nutrient analyzer	11,540.00	NA
Do not replace	NA	Colorimeter	18,000.00	NA
Do not replace	NA	Microscope	17,306.00	NA
Do not replace	NA	Spectrophotometer	18,920.00	NA
Do not replace	NA	R2506, RV No Name (status=active), Class I	21,000	NA
Do not replace	NA	R1102, RV No Name (status=active), Class I	8,000	NA
Do not replace	NA	R3202, GLERL (status=inactive), Class II	60,000	NA
Do not replace	NA	R2106, RV No Name (status=active), Class I	25,000	NA
Do not replace	NA	R1501, RV No Name (status=active), Class A	25,000	NA
Do not replace	NA	R2306, RV No Name (status=active), Class I	32,000	NA
Do not replace	NA	R1301, RV No Name (status=active), Class A	5,000	NA
Do not replace	NA	Fathometer	40,592.40	NA
Do not replace	NA	YSI 6600	10,582.50	NA
Do not replace	NA	YSI 6600	10,582.50	NA
Do not replace	NA	YSI 6600	21,812.00	NA
Do not replace	NA	YSI 6600	21,812.00	NA
Do not replace	NA	Radiometer	23,934.37	NA
Do not replace	NA	Radiometer	34,000.00	NA
Do not replace	NA	Fluorometer	11,605.60	NA
Do not replace	NA	Measure, Liquid, Laboratory	11,100.00	NA
Do not replace	NA	Detector	23,000.00	NA
Do not replace	NA	Extraction System	22,175.63	NA
wish list < 5 years	replace every < 5 years	Fluoroprobe		$35,000
wish list < 5 years	replace every < 5 years	Fluoroprobe		$35,000
wish list < 5 years	replace every < 5 years	Thermister chain		$20,000

wish list < 5 years	replace every < 5 years	Bottom pressure recorder		$12,000
wish list < 5 years	replace every 10 years	Incubatory, Laboratory		14,000.00
wish list < 5 years	replace every 5-10 years	Dissecting scope bundle (scope, camera, software, fluorescence cube)		$19,000
wish list < 5 years	replace every 5-10 years	Fluorometers (for Ashley and Hank)		$34,000
wish list < 5 years	replace every 5-10 years	Unmanned Air Systems (Three drones, two different types)		$70,000
wish list < 5 years	replace every 5-10 years	Single frequency 120 kHz fisheries acoustics - wave glider		$150,000
wish list < 5 years	replace every 5-10 years	Haul-mounted ADCP		$50,000
wish list < 5 years	replace every 5-10 years	Imaging multibeam sonar		$100,000
wish list < 5 years	replace every 5-10 years	Mussel mooring bundle (expansion). Two more moorings. Each mooring - construction of equipment and instrumentation (fluorometer-8500; 2 K misc. instrumentation; construction for mooring $1500 = total of 12K for each mooring)		$12,000
wish list < 5 years	replace every 5-10 years	Mussel mooring bundle (expansion). Two more moorings. Each mooring - construction of equipment and instrumentation (fluorometer-8500; 2 K misc. instrumentation; construction for mooring $1500 = total of 12K for each mooring)		$12,000
wish list 5-10 years	replace every < 5 years	Environmental Sample Processor accessories (including pressure housing, mooring/telecoms, deployment base, and pucks)		$200,000
wish list 5-10 years	replace every < 5 years	Environmental Sample Processor accessories (including pressure housing, mooring/telecoms, deployment base, and pucks)		$200,000
wish list 5-10 years	replace every < 5 years	Environmental Sample Processor accessories (including pressure housing, mooring/telecoms, deployment base, and pucks)		$200,000
wish list 5-10 years	replace every < 5 years	Environmental Sample Processor accessories (including pressure housing, mooring/telecoms, deployment base, and pucks)		$200,000
wish list 5-10 years	replace every 5-10 years	Environmental Sample Processor 2G		$179,400
wish list 5-10 years	replace every 5-10 years	Environmental Sample Processor 2G		$179,400
wish list 5-10 years	replace every 5-10 years	Environmental Sample Processor 2G		$179,400
wish list 5-10 years	replace every 5-10 years	Environmental Sample Processor 3G		$179,400
wish list 5-10 years	replace every 5-10 years	AUV/glider for 3G ESP		$500,000